PPG Industries, Inc.
OXY USA
CITGO Petroleum Corporation
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Bayou d'Inde Group

August 27, 2009

Mr. Keith Casanova
Louisiana Department of Environmental Quality
Office of Environmental Assessment
Remediation Services Division
P.O. Box 4314
Baton Rouge, Louisiana 70821-4314

Re: Bayou d'Inde Group Cooperative Agreement
AI No. 7443
Corrective Action Study Report

Dear Mr. Casanova:

As required by the Cooperative Agreement (CA) and in response to comments provided by LDEQ on the draft Corrective Action Study report, the Bayou d'Inde Group is submitting the enclosed revised Corrective Action Study report. A summary of the combined agency comments and the Bayou d'Inde Group's responses to the comments is also attached to this letter. The comment responses indicate the specific changes made to the Corrective Action Study report.

Should you need additional information, please call me at 337-708-4830.

Sincerely,

Michael K. Huber

Michael K. Huber
Bayou d'Inde Group Project Manager

Submitted in Triplicate

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Combined Agency Comments and Bayou d'Inde Group Responses

In a letter dated July 8, 2009, LDEQ provided combined agency comments on the July 2008 revision of the Bayou d'Inde *Corrective Action Study Report*. The combined agency comments are repeated in the following summary along with the Bayou d'Inde Group's response to each comment. The responses include specific references to the modifications made to the *Corrective Action Study Report*.

Comment 1. Sect 2.1, pg. 15: Delete the end of the last sentence on the page to read: "Therefore, these threshold values can and should be used as guidelines during the development and evaluation of remedial actions to measure the overall effectiveness of a proposed action."

Response: The sentence was deleted (bottom of page 17).

Comment 2. Sect 2.1, pg. 15: Clarify that the mean PEC-Q values used for the evaluation of the Corrective Action Study (CAS) were categorized as described in the EPA Calcasieu Estuary Baseline Ecological Risk Assessment (BERA) report.

Response: The last paragraph on page 17 was modified in three places to add the phrase "...in the BERA" following the phrase "...by EPA".

Comment 3. Sect 2.4.2.1, pg 26: Change will to may in the second paragraph, to read: Total PCB concentrations at the Site are predominantly within these ranges, suggesting that any additional PCB response action may adequately address impacts of this COC to the Site."

Response: The edit was incorporated into the specified section. The modified paragraph is actually the fifth paragraph in the section, not the second.

Comment 4. A description of the depths of dredging (i.e., number of feet of sediment removed) proposed for Area of Investigation (AOI) 2 (Option 2) should be provided in Figure 3-13.

Response: Figure 3-13 was modified to include several labels indicating target dredging depths for various areas in AOI 2. In addition, a profile indicating target dredging depths in the centerline of AOI 2 was added to Figure 3-13 for Removal

Option 2. For consistency, similar modifications were made to Figure 3-10 (for Removal Option 1).

Comment 5. The ARARs should be fully identified and described before an alternative is selected in a decision document. Therefore, the ARARs evaluation in Section 4 should be revised to provide a comprehensive description of the requirements that are associated with the action alternatives.

Response: A comprehensive list of potential ARARs associated with the remedial alternatives evaluated for the Site has been added to the CAS in a new appendix (Appendix H), and the discussion of ARARs in Sections 4 has been modified to cite this appendix and link the evaluation of alternatives relative to ARARs to the list of ARARs in the appendix.

Comment 6. Section 4.4.2, page 84: Additional information regarding containment of the sediment (dredged from AOI 2) that will be used as a cap in AOI 4 should be provided in the CAS.

Response: As previously stated in the CAS document, sediment dredged from AOI 2 would be managed in a portion of AOI 4 prior to implementing remedial action (placement of the 6-Inch Cover) in AOI 4. The CAS does not propose using sediment dredged from AOI 2 as a "cap" or for the proposed 6-Inch Cover in AOI 4. Also as previously stated, the sediment placed in AOI 4 would be contained, perhaps by raising the elevation of the existing roads and building additional earthen levees as necessary. The containment would apply to both the placement of sediment dredged from AOI 2 as well as to the placement of the 6-Inch Cover.

Comment 7. The effectiveness evaluation of remedial alternatives presented in Tables 4-1 through 4-5 should be revised to include the projected changes in human health risk associated with the various proposed remedial alternatives.

Response: The projected changes in human health risk associated with the various proposed remedial alternatives have been included in Tables 4-1 through 4-4.

These changes were not included in Table 4-5 because this table only presents information relevant to the Aquatic Organism receptor group.

Comment 8. Section 5.5: Biomonitoring is an important component of the overall remedial strategy to gauge the effectiveness of the remediation. As such, a detailed description of the proposed biomonitoring program should be included in the CAS.

Response: A discussion of the proposed biomonitoring program currently is included in Section 5.5. A detailed description of the proposed program has been added to the CAS in a new appendix (Appendix I).

Comment 9. The CAS should include a long-term monitoring plan to evaluate the effectiveness of the articulated block mat cap proposed for AOI 1 and the sediment cap proposed for AOI 3 and 4. The plan should include post-placement sampling to ensure that the cap was properly installed and periodic evaluation of the cap to ensure the long-term effectiveness. Appropriate institutional controls should be included to further ensure the success of the remedial actions.

Response: Post-construction confirmation sampling will be conducted to ensure that the articulated block mat (ABM) cap proposed for AOI 1 and the minimum 6-inch cover proposed for AOI 3 and AOI 4 have been placed as designed. Because the ABM cap proposed for AOI 1 is an isolation cap, a long-term monitoring plan for the cap will be designed during the design phase to ensure the long-term performance of the cap. The minimum 6-inch cover proposed for AOI 3 and AOI 4, on the other hand, is not an isolation cap. A certain amount of mixing of the cover material with the existing substrate is expected during placement, and the placement of the cover material itself is expected to achieve the desired reduction in surficial concentrations. While there may be some limited movement of the cover over time under certain conditions, this movement will not adversely affect the original benefit from placement of the cover material. Therefore, there is no need for long-term monitoring of the cover material in AOI 3 and AOI 4, and the CAS does not include a long-term monitoring plan for the sediment covers.

Section 5.5 has been modified to reflect the above approach to post-construction sampling and monitoring. In addition, appropriate institutional controls that will ensure the success of the remedial actions will be considered during the design phase of the project.

CORRECTIVE ACTION STUDY REPORT

BAYOU D'INDE SITE
CALCASIEU PARISH, LOUISIANA
AGENCY INTEREST 7443

August 2009

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ABM	Articulated Block Mat
AOC	Area of Concern
AOI	Area of Investigation
ARAR	Applicable or Relevant and Appropriate Requirements
BERA	Baseline Ecological Risk Assessment
CAS	Corrective Action Study
cm	centimeter
COC	contaminants of concern
cy	cubic yard
EPA	U.S. Environmental Protection Agency
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
LA-108	Louisiana Highway 108
LAC	Louisiana Administrative Code
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health and Hospitals
LDOTD	Louisiana Department of Transportation and Development
LDWF	Louisiana Department of Wildlife and Fisheries
LPDES	Louisiana Pollutant Discharge Elimination System
mg/kg	milligrams per kilogram
MNR	Monitored Natural Recovery
N/m^2	Newton per square meter
NCP	National Contingency Plan
ng/kg	nanograms per kilogram
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PEC	Probable Effects Concentration
PEC-Q	Probable Effects Concentration Quotient
ppm	parts per million
ppt	parts per thousand
RCRA	Resource Conservation and Recovery Act
RECAP	Risk Evaluation/Corrective Action Program

RI	Remedial Investigation
RS	RECAP Standard
SWA	surface weighted average
TCDD	2, 3, 7 8-tetrachlorodibenzodioxin
TDI	total daily intake
TEQ	Toxic Equivalent
TMV	Toxicity, mobility, or volume
USACE	U.S. Army Corps of Engineers
USM	Uniform Section Mat
WQS	Water Quality Standards

EXECUTIVE SUMMARY

The Bayou d'Inde Group entered into a Cooperative Agreement with the Louisiana Department of Environmental Quality (LDEQ) on December 15, 2003 (LDEQ 2003) to perform a Corrective Action Study (CAS) for Bayou d'Inde (the "Site," as defined in the Cooperative Agreement). The purpose of the CAS is to evaluate alternatives for addressing potential risks posed to ecological and human receptors as a result of exposure to sediment-based contaminants of concern (COCs) and to provide the basis for selecting a remedial action[1] from among the alternatives evaluated. A *Draft Corrective Action Study Report* (Anchor 2006b) was submitted to LDEQ on October 5, 2006. A revised *Corrective Action Study Report* was submitted to LDEQ on July 17, 2008. The revised report incorporated comments by LDEQ, the U.S. Environmental Protection Agency Region 6 (EPA), and the National Oceanic and Atmospheric Administration (NOAA) dated March 13, 2008 (which superseded previous comments, dated January 9, 2007). LDEQ transmitted combined agency comments on the revised *Corrective Action Study Report* to the Bayou d'Inde Group in a letter dated July 8, 2009. This current version of the *Corrective Action Study Report* incorporates these latest agency comments.

The *Corrective Action Study Report* documents the development and evaluation of corrective action alternatives for Bayou d'Inde. The overall approach taken in the development of remedial alternatives for the Site is consistent with a phased or adaptive management approach to risk management to reduce or eliminate incremental risks resulting from exposure to COCs in sediments. This approach is based on the iterative approach recommended by EPA for contaminated sediment sites (EPA 2005).

The Site is one of five Areas of Concern (AOC) identified in the Calcasieu Estuary Study Area Remedial Investigation (RI) report prepared on behalf of EPA and LDEQ. The Calcasieu Estuary Study Area comprises the tidally influenced portion of the Calcasieu River in Calcasieu Parish in southwestern Louisiana and associated tributary streams, marshes, and backwater areas.

Following completion of the RI, the EPA and LDEQ entered into a Memorandum of Agreement that designated LDEQ as lead responsible agency for Bayou d'Inde. LDEQ subsequently entered into a Cooperative Agreement with the member companies of the Bayou d'Inde Group

[1] As defined in LAC 33:VI.117 (*remedial action*).

to identify Areas of Investigation (AOIs) within the Site, develop a remedial standard for the Site, and evaluate remedial actions that would achieve the remedial standard. The site history and environmental setting are described in greater detail in Section 1 of this report.

The Bayou d'Inde Group proposed the following four AOIs:

- **AOI 1**—the segment of Bayou d'Inde from its confluence with Little Bayou d'Inde to LA-108
- **AOI 2**—the dredged main channel of Bayou d'Inde between LA-108 and its confluence with the Calcasieu River Ship Channel
- **AOI 3**—the fringe marshes along the banks of Bayou d'Inde between LA-108 and the PPG Canal
- **AOI 4**—Lockport Marsh, along both banks of Bayou d'Inde below the PPG Canal

Using these AOIs to better demarcate the physical and biological features of the Site, the Group proposed a remedial standard (Anchor 2005a) and performed field investigations to support the CAS. The approved remedial standard was developed using the data collected during the RI and using the results of analyses completed in the RI, the Baseline Ecological Risk Assessment (BERA), and the Human Health Risk Assessment (HHRA). In general, as a result of its analyses, EPA concluded that there were incremental risks to aquatic organisms (i.e., benthic invertebrates, fish, and aquatic plants), aquatic-dependent wildlife (i.e., piscivorous birds and mammals), and human receptors as a result of exposure to chemical constituents in sediments, prey tissue, and seafood in the Bayou d'Inde Study Area.

The approved remedial standard for the Site is a six-step progressive response action approach that will reduce estimated incremental risks to aquatic organisms, aquatic-dependent wildlife, and humans to levels that are protective of human health and the environment in each of the four Bayou d'Inde AOIs. The approved remedial standard is used to identify areas within each AOI where sediment-based response actions will result in significant incremental risk reduction. The degree of risk reduction is evaluated through the use of the EPA risk assessment methodologies developed in the BERA and HHRA and the risk-based protocols used by the State of Louisiana to evaluate the need for seafood consumption advisories.

The approved remedial standard begins with an evaluation of risk to aquatic organisms. The BERA estimated incremental risks to the aquatic organisms receptor group through the use of the sediment-based mean probable effects concentration (mean PEC-Q) predictive model. The approved remedial standard also incorporates the mean PEC-Q predictive model because it evaluates the risk of COCs in sediments and incorporates multiple COCs. The mean PEC-Q predictive model is used to identify areas within each AOI where estimated incremental risks to the aquatic organisms receptor group are the highest.

The approved remedial standard also addresses potential risks to aquatic-dependent wildlife and to humans. The BERA concluded that estimated incremental risks to piscivorous birds arise principally from exposure to mercury and total TEQ in the tissues of prey items, and that estimated incremental risks to piscivorous mammals arise principally from exposure to total PCBs (Aroclors) in the tissue of prey items. Similarly, the HHRA concluded that estimated excess cancer and non-cancer risks to human receptors arise principally from exposure to dioxins/furans and PCBs in seafood tissues. Sediments are the primary exposure pathway for aquatic organisms, and are a potential source of mercury, dioxin/furan toxic equivalents (TEQs), total TEQ, and total PCBs (Aroclors) in prey items consumed by aquatic-dependent wildlife and seafood consumed by humans. Therefore, estimated incremental risks to these receptor groups that are associated with the Site may be reduced through the implementation of sediment-based corrective actions at the Site.

The approved remedial standard is followed independently for each of the four AOIs in Bayou d'Inde, because the relative distribution of estimated incremental risks to the three receptor groups is not the same in all of the AOIs. In addition to applying the remedial standard on an AOI-wide basis, the degree to which remedial actions completed in each AOI reduce estimated incremental risks to wide-ranging aquatic-dependent wildlife is evaluated on a Site-wide basis. This approach ensures that exposure and risks to birds and mammals, and some of their prey items, that may forage over areas within the Site that are larger than a single AOI are adequately and properly characterized. In these instances, exposure and the resulting potential risk is integrated on a Site-wide scale and the success of remedial actions should be evaluated on a Site-wide scale as well. The development and implementation of the approved remedial standard at the Site is described in greater detail in Section 2 of this report.

Remedial alternatives were developed for each of the four AOIs considering the degree of potential risk reduction (assessed using the measures identified in the remedial standard), physical conditions of the AOI (such as water depth and surface water velocity), and uses of the AOI (such as barge/tug traffic). The remedial alternatives fell into several broad categories of response action. These categories are:

- No Further Action (required by regulation for comparison as a baseline)
- Adaptive Management/Biomonitoring
- Monitored Natural Recovery (MNR)
- Sediment Cover
- In Situ Capping
- Removal

No Further Action is an alternative that results in no action being taken to address risks identified in the RI.

Adaptive Management coupled with biomonitoring is a flexible remedial strategy that uses ongoing monitoring to assess the effectiveness of remedial actions that are being incrementally implemented. Biomonitoring is proposed as a means of evaluating the effectiveness of remedial action Site-wide by directly measuring concentrations of COCs in the tissue of certain classes of aquatic organisms at the Site. Additional remedial action can occur if biomonitoring indicates that such action is warranted.

MNR is a remedial strategy that uses some form of sampling and analysis to confirm the degree to which natural processes that reduce exposure to COCs at the Site are achieving the remedial standard.

Sediment Cover is an alternative that involves placing a cover of clean sediment over native sediment in a manner that anticipates some mixing with the native sediment, thereby substantially and permanently lowering concentrations of COCs throughout a shallow mixing zone interval.

In Situ Capping involves placing clean sediment, other fill, or an engineered material in areas of impacted sediment to provide a chemical isolation barrier between impacted sediment and

potential receptors. In situ caps are typically designed to resist erosion caused by the movement of surface water above the cap.

Removal of sediment involves physically removing sediment from an area of potential exposure to receptors and placing the sediment in an area where the likelihood of exposure of receptors to COCs is reduced.

Section 3 of this report describes the development of remedial alternatives specific to the conditions in the four AOIs within these broad categories of response actions. Some of the categories of response action were not applicable to some of the AOIs, for reasons identified in Section 3. In addition, remedial alternatives that would be ineffective in achieving the remedial standard, were not implementable, or that would be much more expensive than other alternatives in achieving the remedial standard were screened from further consideration, in accordance with Louisiana regulations. The screening process is described in Section 3.

The remedial alternatives that passed the screening step were evaluated in detail using criteria stipulated in Louisiana regulations and the Cooperative Agreement. The evaluation criteria are:

1. Ability of the remedial alternatives to achieve the approved remedial standard
2. The long-term effectiveness and permanence of the remedial alternatives
3. Reduction of toxicity, mobility, or volume (TMV) of hazardous constituents through treatment
4. Short-term effectiveness
5. Implementability
6. Cost effectiveness
7. Compliance with all applicable or relevant and appropriate requirements of state and federal environmental laws (ARARs)

The detailed evaluation of remedial alternatives is described in Section 4 of this report. Based on the detailed evaluation, the following remedial actions will achieve the remedial standard for the Site, are protective of human health and the environment, comply with ARARs, and represent the best balance of effectiveness (both short- and long-term), implementability, and cost among the remedial alternatives evaluated.

- AOI 1: In situ capping of approximately 36,000 square yards of sediment using articulated block mat (ABM) technology
- AOI 2: Removal of approximately 97,000 cubic yards of sediment between the PPG Canal and the mouth of Bayou d'Inde, essentially restoring the 1967 dredged channel in that reach. The sediment would be consolidated into a portion of AOI 4 and capped (see below).
- AOI 3: Placement of a 6-inch cover of clean sediment over approximately 39 acres of sediment in the fringe marshes (mostly open water areas).
- AOI 4: Placement of a 6-inch cover of clean sediment over approximately 123 acres of sediment in Lockport Marsh, including sediment consolidated from AOI 2 into a portion of AOI 4 bordered by oil field roads and the PPG Canal.
- A post-remedy biomonitoring program to measure concentrations of PCBs and TEQ in fish and shellfish tissues in Bayou d'Inde.

1 INTRODUCTION

The Bayou d'Inde Group entered into a Cooperative Agreement with the Louisiana Department of Environmental Quality (LDEQ) on December 15, 2003 (LDEQ 2003) to perform a Corrective Action Study (CAS) for Bayou d'Inde (the "Site," as defined in the Cooperative Agreement). The purpose of the CAS is to evaluate alternatives for addressing potential risks posed to ecological and human receptors as a result of exposure to sediment-based contaminants of concern (COCs) and to provide the basis for selecting a remedial action[2] from among the alternatives evaluated. A *Draft Corrective Action Study Report* (Anchor 2006b) was submitted to LDEQ on October 5, 2006. A revised *Corrective Action Study Report* was submitted to LDEQ on July 17, 2008. The revised report incorporated comments by LDEQ, the U.S. Environmental Protection Agency Region 6 (EPA), and the National Oceanic and Atmospheric Administration (NOAA) dated March 13, 2008 (which superseded previous comments, dated January 9, 2007). LDEQ transmitted combined agency comments on the revised *Corrective Action Study Report* to the Bayou d'Inde Group in a letter dated July 8, 2009. This current version of the *Corrective Action Study Report* incorporates these latest agency comments.

The revised *Corrective Action Study Report* documents the development and evaluation of corrective action alternatives for Bayou d'Inde in compliance with the requirements of the Cooperative Agreement.

The CAS uses and builds upon data collected by EPA and reported in the Calcasieu Estuary Remedial Investigation (RI) Report (CDM 2003). The RI defined the nature and extent of contamination within the Calcasieu Estuary Study Area, identified potential receptors and exposure pathways, and assessed potential risks to these receptors from exposure to COCs. EPA and LDEQ entered into a Memorandum of Agreement on May 6, 2003, that identified five Areas of Concern (AOCs) within the Calcasieu Estuary Study Area that require further response action and designated the lead response agency for each of the five AOCs. The five AOCs, and the lead agency for each, are:

- Bayou d'Inde (LDEQ)
- Bayou Verdine (EPA)
- Citgo Lagoon and Indian Marais Bayou (LDEQ)
- Clooney Island Loop (EPA)

[2] As defined in Louisiana Administrative Code (LAC) 33:VI.117 (*remedial action*).

- Coon Island Loop (EPA)

LDEQ concluded that the RI satisfied the requirements of the Louisiana Administrative Code (LAC), Title 33, Part VI, Section 507 for an investigation of the nature and extent of contamination for the Site, except that the RI did not establish Preliminary Risk Evaluation/Corrective Action Program (RECAP) Standards (Preliminary RS) as required by LAC 33:VI.507.C.3. As required by the Cooperative Agreement, Section VI.3, the Bayou d'Inde Group proposed Preliminary RS and segregated the Bayou into Areas of Investigation (AOIs). The Preliminary RS is a remedial standard that, when met, is protective of human health and the environment within Bayou d'Inde. The approved remedial standard is discussed in Section 2 of this revised CAS Report. The process for development of the Preliminary RS and the delineation of AOIs can be found in the *Technical Memorandum: Delineation of Areas of Investigation and Proposed Preliminary RECAP Standards for Bayou d'Inde* (Technical Memorandum; Anchor 2005a). LDEQ approved the Technical Memorandum in a letter to the Bayou d'Inde Group dated May 12, 2005 (LDEQ 2005).

Several documents have been prepared and submitted to LDEQ to support the Bayou d'Inde CAS, including:

- *Work Plan for the Delineation of Areas of Investigation, Development of Preliminary RECAP Standards, and Performance of a Corrective Action Study* (CAS Work Plan; Anchor 2004)
- *Technical Memorandum: Delineation of Areas of Investigation and Proposed Preliminary RECAP Standards for Bayou d'Inde* (Anchor 2005a)
- *Work Plan Addendum: Draft Sampling and Analysis Plan* (Work Plan Addendum; Anchor 2005b), which was modified by the Sampling and Analysis Plan Addendum (Anchor 2005c)
- *Data Summary Report, Comparison of Pre- and Post-Hurricane Rita Sediment Chemistry* (Anchor 2006a)
- *Draft Corrective Action Study Report* (Anchor 2006b)
- *Supplemental Sampling and Analysis Plan* (Anchor 2007)

The Bayou d'Inde Group collected sediment samples from AOIs 1, 3, and 4 and the Calcasieu River Ship Channel and began monitoring surface water flow data in AOIs 3 and 4 in November and December 2005. The sampling event also included collecting additional

sediment samples at the request of LDEQ to assess potential effects from Hurricane Rita. The results of the additional post-hurricane sampling were reported to LDEQ in the *Data Summary Report, Comparison of Pre- and Post-Hurricane Rita Sediment Chemistry* (Anchor 2006a).

In response to preliminary agency comments on the October 2006 *Draft Corrective Action Study Report* (Anchor 2006b), the Bayou d'Inde Group proposed additional sediment sampling in the *Supplemental Sampling and Analysis Plan* (Anchor 2007). LDEQ approved the plan for supplemental sampling in a letter dated May 25, 2007. The results of the supplemental sampling are incorporated into this revised CAS Report (Appendix A and Appendix E). This revised CAS Report also addresses agency comments contained in the March 13, 2008 letter to the Bayou d'Inde Group (LDEQ 2008).

1.1 Site History

Major industry first appeared in Bayou d'Inde in the 1920s, and as a result of the discovery of petroleum, natural gas, lumber and other raw materials, rapid industrial development of the area occurred (CDM 2003). The Calcasieu River Ship Channel was first dredged in the 1920s and deepened in the 1960s (Lake Charles Association of Commerce 1963). Channelization of coastal rivers is commonly associated with saltwater intrusion (a saltwater barrier was installed in the Calcasieu River north of Lake Charles in 1968), and salinity within the Site, particularly near the mouth of Bayou d'Inde, has likely increased as a result of dredging the ship channel. Louisiana Department of Transportation and Development (LDOTD) records document that Bayou d'Inde was dredged in 1959 and 1967. The most recent dredging, in 1967, involved dredging a 15-foot deep by 78-foot wide channel section within the Bayou d'Inde main channel from Louisiana Highway 108 (LA-108) to the mouth of the bayou at the Ship Channel, a distance of approximately 4 miles (Louisiana Department of Public Works 1966 and 1968).

1.2 Site Setting

Bayou d'Inde is located in the northern part of the Calcasieu River Estuary, west of the City of Lake Charles, Louisiana. Figure 1-1 shows the location of Bayou d'Inde relative to other features in the Calcasieu Estuary and southwest Louisiana. A tributary to the Calcasieu River, Bayou d'Inde flows approximately 9.3 miles east and southeast from its headwaters near the City of Sulphur, Louisiana, into the Calcasieu River Ship Channel. The Cooperative

Agreement defines the Site as the portion of Bayou d'Inde from the confluence of Little Bayou d'Inde to the Calcasieu River Ship Channel, including the fringe marshes along the banks of Bayou d'Inde downstream of the LA-108 bridge (including near the confluence of Maple Fork) to the 470-acre Lockport Marsh located at the confluence of Bayou d'Inde and the Calcasieu River Ship Channel.

Figure 1-2 identifies Bayou d'Inde and adjacent surface waters relative to other nearby features—including the cities of Lake Charles and Sulphur, interstate highways, and the Calcasieu River Ship Channel—in an aerial photograph.

Figure 1-3 presents the topography of the land around the Site. Bayou d'Inde drains an area of more than 21,000 acres (ARCADIS G&M, Inc. 2002) and is fed by several tributaries, including Maple Fork, Little Bayou d'Inde, and the PPG Canal. Based on a review of historical aerial photographs, Lockport Marsh and the upstream fringe marshes are largely shallow backwater areas that have subsided below mean water levels over the last half-century.

The RI described the Site in terms of bayou and marsh energy systems. Bayou d'Inde ranges from approximately 100 to 300 feet in width and the water depths in deepest parts of the main channel range from approximately 12 to 18 feet. Salinity in the Bayou d'Inde main channel ranges from 1 to 27 parts per thousand (ppt) with an average of 13 to 16 ppt (CDM 2003). Marshes and backwater areas are low-energy sediment sinks with slow draining basins. They have shallow water depths that are susceptible to temporary dewatering during strong northerly winds and/or low tide. Salinity in the marshes and backwaters adjacent to Bayou d'Inde ranges from 2 to 27 ppt, with an average of 19 ppt (CDM 2003). Both the bayou and marsh/backwater systems are subject to changes in downstream flow (rainfall and permitted discharges) and tidal flux.

The general weather in the area is mild; the average temperature is 68°F and Lake Charles received 44 inches of rain in 2003 (NOAA 2003). The surface elevation in the bayou averages 3.1 feet above mean sea level (CDM 2003). Because of the low elevation of the bayou and its proximity to the Gulf of Mexico, characteristics such as salinity, sediment porewater, and water depth vary with rainfall, tide, storm surge, and winds. The area is

also vulnerable to hurricane influence, which can cause greater short-term changes in salinity, water depth, turbidity, and other environmental conditions.

Land use in the Bayou d'Inde drainage includes undeveloped wooded marshland, rural residential, commercial, and heavy industrial properties (CDM 2003). Approximately two-thirds of the land adjacent to the Site is undeveloped woodland and marsh. Developed land adjacent to the Site is dominated by industrial uses, with a small percentage in rural residential use. Streets and highways in the vicinity of Bayou d'Inde, as well as zoned land uses on properties in or adjacent to the Site, are illustrated on Figure 1-4. Although dredging and other development activities have altered natural habitats, Bayou d'Inde supports a variety of wildlife. Mammals, birds, reptiles, and fish are all found in the bayou environment.

The sediments within the marsh/backwaters and bayou areas of Bayou d'Inde are composed of various proportions of clay, silt, sand, and organic matter. Grain size distributions of marsh/backwater sediments average 24 percent clay, 44 percent silt, and 34 percent sand. As described in Appendix D, grain size distribution in near-surface bayou sediments range from 26 to 61 percent clay, from 38 to 48 percent silt, and from 1 to 35 percent sand. The marsh system has the highest proportion (44 percent) of silt-sized sediments (CDM 2003). The marsh and backwater areas of the Site tend to accumulate sediment, although multiple factors can affect sediment deposition rates.

Four AOIs were defined for Bayou d'Inde in the approved Technical Memorandum (Anchor 2005a). They are identified as:

- **AOI 1**—the segment of Bayou d'Inde from its confluence with Little Bayou d'Inde to LA-108
- **AOI 2**—the dredged main channel of Bayou d'Inde between LA-108 and its confluence with the Calcasieu River Ship Channel
- **AOI 3**—the fringe marshes along the banks of Bayou d'Inde between LA-108 and the PPG Canal
- **AOI 4**—Lockport Marsh, along both banks of Bayou d'Inde below the PPG Canal

The AOIs are illustrated on Figure 1-5.

1.3 CAS Approach

This revised CAS Report presents the development and evaluation of remedial alternatives for the Site, including a discussion of the data gathered and analyses performed to support the evaluation of remedial alternatives. The data from the RI and additional evaluations performed as part of the CAS process provide sufficient information to understand the primary source control and incremental risk issues associated with the Site. The overall approach taken in the development of remedial alternatives for the Site is consistent with a phased or adaptive management approach to risk management to reduce or eliminate incremental risks resulting from exposure to COCs in sediments. This approach is based on the iterative approach recommended by EPA for contaminated sediment sites (EPA 2005). For the CAS, this RECAP-based approach involves identifying a combination of corrective actions that will reduce estimated incremental risks to potential ecological and human receptors. A monitoring program to evaluate the long-term effectiveness of those corrective actions will be implemented after the selected corrective actions are implemented.

This CAS report is organized as follows: Section 2 presents a summary of the approved remedial standard, which was developed in the Technical Memorandum (Anchor 2005a) and approved by LDEQ in May 2005 (LDEQ 2005). Section 3 describes the development and screening of remedial alternatives for each of the AOIs, including brief summaries of the findings of the data evaluations that are particularly significant to the development and evaluation of remedial alternatives. Additional details of the data evaluations are presented in appendices to this report. Section 4 presents the detailed evaluation of the remedial alternatives. Section 5 summarizes the conclusions of the detailed analysis of alternatives for the Site.

2 REVIEW OF THE APPROVED REMEDIAL STANDARD

Section IX.A.3 of the Cooperative Agreement requires that the CAS Report identify the approved remedial standard. The Bayou d'Inde Group proposed a Preliminary RS consistent with LAC 33.VI.507.C.3 in a Technical Memorandum prepared by Anchor (2005a). LDEQ approved the Technical Memorandum in a letter to the Bayou d'Inde Group dated May 12, 2005 (LDEQ 2005). Consistent with the Cooperative Agreement, the CAS Report uses the approved Preliminary RS as the approved remedial standard. The Technical Memorandum (Anchor 2005a) and the relevant portions of the RI, the *Calcasieu Estuary Baseline Ecological Risk Assessment* (BERA; MacDonald Environmental Sciences Ltd. 2002), and the *Calcasieu Estuary Human Health Risk Assessment* (HHRA; CDM 2002) should be consulted for details regarding the development of the approved remedial standard and the underlying data and analyses that support its development. The purpose of this section is to review the approved remedial standard and describe the analyses that are used to demonstrate that the approved remedial standard will be met as a result of the implementation of remedial actions within the Site.

2.1 Review of Risk Assessment Results

The approved remedial standard was developed using the data collected during the RI and using the results of analyses completed in the RI, the BERA, and the HHRA. The RI and risk assessments by EPA were necessarily broad in scope due to the geographic area covered. Uncertainties remain in the level of understanding of the nature and extent of contamination and the degree to which this contamination poses unacceptable risks to human health and the environment in more focused geographic areas such as Bayou d'Inde. These uncertainties are recognized by EPA and LDEQ and are factored into the approved remedial standard.

In the BERA, EPA defined three different risk levels for ecological receptors. These categories are defined in risk management terms as follows:

- Low Risk – risks similar to those for reference conditions
- Indeterminate Risk – elevated risks relative to reference conditions; decisions on remedial actions should consider multiple factors
- High Risk – substantially elevated risks relative to reference conditions; remedial actions are likely required to mitigate risks

In the HHRA, EPA defined risk in terms of excess lifetime cancer risk and in terms of non-cancer hazard indices.

It is important to recognize that risks vary along a continuum; that is, there are no specific known "thresholds" providing definite boundaries separating different levels of risk. For example, areas with risk scores at the low end of the high risk category may be indistinguishable from areas with risk scores in the indeterminate risk category. Similarly, areas with risk scores at the low end of the indeterminate risk category may be indistinguishable from areas with risk scores in the low risk category. Therefore, such risk categories should be used primarily to ensure that areas of Bayou d'Inde that present the greatest estimated incremental risks to human health and the environment are addressed in the evaluation of potential response actions. The approved remedial standard achieves this goal, while recognizing that risks vary along a continuum.

In general, as a result of its analyses, EPA concluded that there were incremental risks to aquatic organisms, aquatic-dependent wildlife, and human receptors as a result of exposure to chemical constituents in sediments, prey tissue, and seafood in the Bayou d'Inde AOC. The following discussion summarizes these findings.

Aquatic Organisms – The aquatic organisms subgroup comprises the following resource classes: benthic invertebrate community, microbial community, aquatic plant community, and the benthic and pelagic fish community. In the BERA, EPA developed a metric, the mean Probable Effects Concentration Quotient (mean PEC-Q), as an indicator of site-specific sediment toxicity to the benthic invertebrate community. Specifically, a mean PEC-Q predictive model was developed by EPA to link the whole-sediment chemistry measurement endpoint (at 315 stations within Bayou d'Inde) and the whole-sediment toxicity measurement endpoint (at 31 stations in Bayou d'Inde) in order to evaluate the magnitude and areal extent of risks to benthic invertebrates over a large area. Because sediment-dwelling organisms are likely to be exposed to mixtures of COCs in whole sediments, rather than individual COCs, it is appropriate to evaluate the effects of sediment-associated COCs using a chemical mixture model of this type.

The mean PEC-Q parameter is calculated for a sediment sample by first dividing measured concentrations of seven metals (arsenic, cadmium, chromium, copper, lead, nickel, and zinc), total polynuclear aromatic hydrocarbons (PAH) (which includes acenaphthene, acenaphthylene, anthracene, fluorene, 2-methyl-naphthalene, naphthalene, phenanthrene, benzo(a)anthracene, dibenzo(a,h)anthracene, benzo(a)pyrene, 1,2-benzphenanthracene, fluoranthene, and pyrene), and total polychlorinated biphenyls (PCBs) (based on PCB Aroclors or congeners) by their respective PECs (see Appendix E1, Table E1-1 in the BERA) to calculate a PEC quotient. The PEC quotients for the seven metals are then averaged to calculate a mean PEC value for metals. The three mean PEC quotients (i.e., for metals, total PAHs, and total PCBs) are then averaged to calculate a mean PEC quotient (i.e., mean PEC-Q) for that sediment sample. This provides a link between the results of the site-specific whole-sediment toxicity tests and whole-sediment chemistry in the Calcasieu Estuary. Therefore, the PEC-Q concept has been integrated into the remedial standard as the first step for determining where response actions should be focused.

Mean PEC-Q values less than 0.33 correlated with sediment toxicity levels that were categorized by EPA in the BERA as presenting low risk to the benthic invertebrate community, values between 0.33 and 0.56 were categorized by EPA in the BERA as presenting indeterminate risk, and values greater than 0.56 were categorized by EPA in the BERA as presenting high risk. As a result of additional analyses, EPA concluded that these values also could be used to categorize risk to the microbial community, the aquatic plant community, and the benthic and pelagic fish communities. The Technical Memorandum (Anchor 2005a) should be consulted for further details regarding the development of the mean PEC-Q metric. As noted above, it is important to understand that estimated incremental risks to the aquatic organisms subgroup vary along a continuum and that mean PEC-Q values of 0.33 and 0.56 do not define dramatic shifts from one risk category to another. The values are based on percentage reductions in test organism survival relative to reference conditions that are considered to be important indicators of relative levels of toxicity; however, differences of a few percentage points in either direction are not critical for overall ecological health management. Therefore, these threshold values can and should be used as guidelines during the development and evaluation of remedial actions to measure the overall effectiveness of a proposed action.

Aquatic-Dependent Wildlife – The aquatic-dependent wildlife subgroup comprises the following resource classes: sediment-probing, carnivorous, and piscivorous birds and omnivorous and piscivorous mammals. In the BERA, EPA concluded that there were (1) incremental risks to piscivorous birds from exposure to mercury and total 2, 3, 7 8-tetrachlorodibenzodioxin Toxic Equivalents (TCDD-TEQ) (from dioxins/furans and coplanar PCB compounds) (total TEQ) in the tissues of prey items; and (2) incremental risks to piscivorous mammals from exposure to total PCBs (Aroclors) in the tissues of prey items.

Estimates of risk were based on the probability of exceedance of lower and upper dose thresholds, as measured by total daily intake (TDI). The effects thresholds for the low and high risk categories were developed based on toxicity thresholds and/or on dose-response curves depending on the particular receptor type. The probability thresholds for the low and high risk categories were developed by EPA's risk assessment team. These thresholds were subjective and were based on the professional judgment of the risk assessment team.

For piscivorous birds, EPA defined the following risk thresholds:

- If the probability of exceeding the lower toxicity threshold is less than 20 percent, the risk to birds is considered low.
- If the probability of exceeding the upper toxicity threshold is greater than 20 percent, the risk to birds is considered high.
- All other probabilities are considered to have indeterminate risk.

For both mercury and total TEQ, the lower toxicity threshold was approximately an order of magnitude less than the upper toxicity threshold, meaning that the indeterminate risk range encompassed a wide range of potential TDIs. Estimated incremental risks to piscivorous birds from exposure to mercury and total TEQ were both in the low end of the indeterminate risk range, meaning that incremental risks were much closer to the low risk threshold than the high risk threshold.

For piscivorous mammals, EPA defined the following risk thresholds:

- If there was less than a 20 percent probability of a 10 percent or greater reduction in fecundity, the risk to mammals was considered low.

- If there was greater than a 50 percent probability of a 20 percent or greater reduction in fecundity, then the risk to mammals was considered high.
- All other outcomes were considered to have indeterminate risk.

For total PCBs, the lower toxicity threshold was approximately a factor of 2 less than the upper toxicity threshold, meaning that the indeterminate risk range encompassed a narrow range of potential TDIs. Estimated incremental risks to piscivorous mammals from exposure to total PCBs (Aroclors) were categorized as high; however, given the narrow indeterminate risk range, remedial actions that result in even modest reductions in total PCBs can have a substantial impact on the degree of estimated incremental risk to piscivorous mammals.

The Technical Memorandum (Anchor 2005a) should be consulted for further details regarding the risk assessment results for aquatic-dependent wildlife. As noted above, it is important to understand that incremental risks to the aquatic-dependent wildlife subgroup vary along a continuum and that lower and upper toxicity thresholds do not define dramatic shifts from one risk category to another—they represent the collective professional judgment of EPA's risk assessment team. These values were used as guidelines during the development and evaluation of remedial actions to measure the overall effectiveness of a proposed action, but were not used as absolute goals.

Human Receptors – The HHRA for the Calcasieu Estuary Study Area estimated current and future risks to humans resulting from direct exposure to contaminated sediments, surface water, fish, and shellfish from the Calcasieu Estuary Study Area in the absence of any remediation. Based on the data and consumption assumptions used, the HHRA concluded that estimated total excess lifetime cancer risks from long-term consumption (70 years) of shellfish from Bayou d'Inde and fish from the Calcasieu Estuary Study Area were above the threshold range of 10^{-6} (1 in 1,000,000 excess cancer risk) to 10^{-4} (1 in 10,000 excess cancer risk). Approximately 90 percent of the estimated total excess cancer risk from resident fish/shellfish consumption was due primarily to the presence of dioxins/furans in shellfish tissue, and secondarily to the presence of PCB (Aroclors), aldrin, bis(2-ethylhexyl)phthalate, arsenic, and beta-BHC in shellfish tissue. The remaining 10 percent of the estimated total excess cancer risk was due primarily to the presence of the following COCs in fish tissue:

arsenic, dioxins/furans, aldrin, dieldrin, and PCB Aroclors. Based on the data and consumption assumptions used in the HHRA, hazard quotients (HQs) for some COCs, including PCB Aroclors, exceeded 1, indicating a potential for non-cancer health effects to occur from long-term ingestion (70 years) of fish and shellfish from Bayou d'Inde.

The above estimates were developed by EPA using several conservative exposure assumptions, including the following:

- Fishers obtain 100 percent of the shellfish (blue crabs) that they eat from Bayou d'Inde, rather than from elsewhere in the estuary or stores/restaurants.
- Fishers eat all of the meat and hepatopancreas ("fat") from each blue crab

In addition, because of the small shellfish sample size in Bayou d'Inde, exposure point concentrations were based on maximum observed values, instead of the 95 percent upper confidence limit based on the mean of those values.

A substantial fraction of the estimated risk associated with recreational and subsistence ingestion of fish and shellfish from the Bayou d'Inde AOC was associated with dioxins/furans and PCBs in fish and shellfish tissues. Given the data and assumptions used in the HHRA, actual risks to humans from these COCs may be lower than were estimated in the HHRA. Again, as noted above, risks to humans also vary along a continuum that is defined primarily by variability in the degree of exposure and the length of time over which exposure occurs. The findings of the HHRA for the Bayou d'Inde Study Area will be considered during the development of remedial alternatives and will be used as guidelines when evaluating the effectiveness of proposed remedial alternatives, but the evaluation should also recognize the conservative assumptions used and the inherent variability in the exposure function. In addition, the effectiveness of proposed remedial alternatives will be evaluated using the risk-based protocols employed by the State of Louisiana to evaluate the need for seafood consumption advisories in State waters.

For purposes of the CAS, key points from the BERA and HHRA are:

- Based on the data and assumptions in the BERA, estimated incremental risks to the four receptor types (benthic invertebrate, microbial, aquatic plant, benthic/pelagic fish) within the aquatic organisms receptor group can be evaluated through the use

of the sediment-based mean PEC-Q predictive model that was developed for Bayou d'Inde. This model is based on the results of site-specific whole-sediment toxicity tests and is a core element of the approved remedial standard for Bayou d'Inde.

- Based on the data and assumptions in the BERA, there are estimated incremental risks to piscivorous birds due to exposure to mercury and total TEQ in the tissue of prey items. These risks fall in the low end of the indeterminate risk range. For piscivorous mammals, there are estimated incremental risks due to exposure to total PCBs (Aroclors) in the tissue of prey items. These risks fall in the high risk range.
- Based on the data and assumptions in the HHRA, the majority of the estimated excess cancer and non-cancer risks to human receptors from seafood obtained in Bayou d'Inde arose from dioxins/furans and PCBs in shellfish tissues.

2.2 Approved Remedial Standard

The approved remedial standard for the Site is a six-step progressive response action approach that will reduce estimated incremental risks to aquatic organisms, aquatic-dependent wildlife, and humans to levels that are protective of human health and the environment in each of the four Bayou d'Inde AOIs. The approved remedial standard is used to identify areas within each AOI where sediment-based response actions will result in significant incremental risk reduction. The degree of risk reduction is evaluated through the use of the EPA risk assessment methodologies developed in the BERA and HHRA and the risk-based protocols used by the State of Louisiana to evaluate the need for seafood consumption advisories.

As will be discussed further, the approved remedial standard begins with an evaluation of risk to aquatic organisms. The BERA estimated incremental risks to the aquatic organisms receptor group through the use of the mean PEC-Q predictive model. The approved remedial standard also incorporates the mean PEC-Q predictive model because it evaluates the risk of COCs in sediments and incorporates multiple COCs. The mean PEC-Q predictive model is used to identify areas within each AOI where estimated incremental risks to the aquatic organisms receptor group are the highest.

The approved remedial standard also addresses potential risks to aquatic-dependent wildlife and to humans. The BERA concluded that estimated incremental risks to

piscivorous birds arise principally from exposure to mercury and total TEQ in the tissues of prey items, and that estimated incremental risks to piscivorous mammals arise principally from exposure to total PCBs (Aroclors) in the tissue of prey items. Similarly, the HHRA concluded that estimated excess cancer and non-cancer risks to human receptors arise principally from exposure to dioxins/furans and PCBs in seafood tissues. Sediments are the primary exposure pathway for aquatic organisms, and are a potential source of mercury, dioxin/furan TEQs, total TEQ, and total PCBs (Aroclors) in prey items consumed by aquatic-dependent wildlife and seafood consumed by humans. Therefore, estimated incremental risks to these receptor groups that are associated with the Site may be reduced through the implementation of sediment-based corrective actions at the Site.

The approved remedial standard is followed independently for each of the four AOIs in Bayou d'Inde, because the relative distribution of estimated incremental risks to the three receptor groups may not be the same in all of the AOIs. The area of each AOI was selected to minimize physical and biological differences within that exposure regime. These attributes allow estimates of exposure and risk to each receptor group to be made in each AOI on an AOI-wide scale.

In addition to applying the remedial standard on an AOI-wide basis, the degree to which remedial actions completed in each AOI reduce estimated incremental risks to wide-ranging aquatic-dependent wildlife is evaluated on a Site-wide basis. This approach ensures that exposure and risks to birds and mammals, and some of their prey items, that may forage over areas within the Site that are larger than a single AOI, are adequately and properly characterized. In these instances, exposure and the resulting potential risk is integrated on a Site-wide scale and the success of remedial actions should be evaluated on a Site-wide scale. As noted above, the approved remedial standard is a six-step progressive approach. Steps 1 through 4 in the process address estimated incremental risks to the aquatic organisms receptor group. Steps 5 and 6 address estimated incremental risks to the aquatic-dependent wildlife receptor group and human receptors. The steps are as follows:

- **Step 1.** Identify and display, using maps and tables, the distribution of mean PEC-Q values within each AOI.
- **Step 2.** Identify sub-areas of the AOI with the highest mean PEC-Q values and sub-areas where contiguous data points exhibit elevated mean PEC-Q values. Prioritize

areas where the greatest overall reduction in the AOI-wide mean PEC-Q value could be achieved from a given amount of remediation effort. Determine the effect on the AOI-wide mean PEC-Q value that would result from implementing a response action.

- **Step 3.** Evaluate the potential effect on the AOI-wide mean PEC-Q value as a result of natural recovery over time in areas with less elevated mean PEC-Q values (or isolated areas with more elevated mean PEC-Q values).
- **Step 4.** If necessary, continue designating sub-areas within each AOI for response action until the estimated AOI-wide mean PEC-Q value for the AOI results in an acceptable level of risk to aquatic organisms. Show that any remaining isolated areas with elevated levels would represent a small percentage of the total area within an AOI, and would not have a material impact on ecological functions (taking into consideration the ecological effects of any proposed resource restoration actions consistent with LAC 33:VI.509.C.5).
- **Step 5.** Evaluate the degree to which actions taken to reduce mean PEC-Q values in each AOI also reduce the potential exposure to mercury, dioxins, and PCBs for those prey classes that represent an important part of the diet of aquatic-dependent wildlife and human receptors. Evaluate how this reduction in exposure translates to a reduction of potential risk to these receptor groups
- **Step 6.** To the extent necessary, evaluate additional response actions in each AOI that will reduce exposure and risk to aquatic-dependent wildlife and human receptors to levels that provide an overall acceptable level of protection to these receptor groups.

The steps are described in more detail in the Technical Memorandum (Anchor 2005a). The following sections describe how the results of the approved remedial standard process are evaluated in terms of risk reduction for the three resource subgroups of interest. The first step in this process is to evaluate existing conditions.

2.3 Baseline Assessment

The results of the baseline assessment are presented in Figures 2-1 through 2-4. The baseline assessment represents current conditions in sediments, as well as conditions that would prevail at least in the short term if no response actions were implemented in a given AOI. In

the Development and Screening of Corrective Action Alternatives (Section 3) and Detailed Evaluation of Alternatives (Section 4), the various remedial alternatives are compared against this baseline to assess the ability of the remedial alternatives to achieve the approved remedial standard. The baseline assessment provides the information necessary to complete Steps 1 and 2 of the approved remedial standard and provides input for the completion of Steps 5 and 6.

2.4 Evaluating Risk Reduction

2.4.1 Aquatic Organisms

In general, risks to ecological communities and populations in areas as large as Bayou d'Inde are not determined by the conditions present at an individual sampling point or location, but by the conditions present in broader geographical areas of elevated concentrations of COCs. Therefore, the approved remedial standard process involves identifying areas where contiguous data points exhibit the highest mean PEC-Q values, and examining the effect that response actions in those areas would have on the AOI-wide mean PEC-Q value. Steps 1 and 2 of the approved remedial standard are completed by delineating sediment areas within each AOI that would be affected by a given remedial alternative and assigning a post-remedy value for the mean PEC-Q metric in the remediated area. Different post-remedy values are assumed for different remedial activities. For example, removal followed by backfilling with clean sediments is assumed to result in a post-remedy mean PEC-Q value in the affected area that is equal to the lowest detectable mean PEC-Q value anywhere in that AOI. The assumptions used for each of the remedial alternatives are discussed in Section 4 of this report.

After steps 1 and 2 are complete, a post-remedy surface weighted average (SWA) mean PEC-Q value is calculated and compared to the pre-remedy SWA mean PEC-Q value so that a percentage reduction can be calculated. The post-remedy SWA mean PEC-Q value is also compared to the 0.33 low/indeterminate risk threshold and the 0.56 indeterminate/high risk threshold to evaluate the post-remedy value in terms of overall risk. As discussed in Section 2.1 and as shown in Figure 2-5, mean PEC-Q values, and therefore estimated incremental risks to aquatic organisms, vary along a continuum.

The evaluation of areas within an AOI using the mean PEC-Q metric will consider this range during Step 2 of the approved remedial standard.

Consistent with Steps 1 and 2, Steps 3 and 4 of the approved remedial standard involve the evaluation of natural recovery over time in areas exhibiting relatively lower mean PEC-Q values, assuming that areas with relatively higher mean PEC-Q values will be subject to response actions. The evaluation includes determining whether any remaining areas with elevated mean PEC-Q values would represent a sufficiently small proportion of the total AOI that they would not be expected to materially affect ecological functions. The evaluation includes consideration of the ecological effects of any proposed resource restoration actions, consistent with LAC 33:VI.509.C.5. These steps are designed to determine whether a combination of response actions, natural recovery, and resource restoration will yield an AOI-wide PEC-Q value and other results that are protective of the aquatic organisms receptor group. In addition, further reductions in SWA mean PEC-Q values may occur as a result of remedial activities that are implemented to specifically address the other chemical constituents of interest (mercury, total TEQ, and PCBs).

2.4.2 *Aquatic-Dependent Wildlife and Humans*

The BERA and the HHRA concluded there are incremental risks to aquatic-dependent wildlife and humans as a result of consumption of fish and shellfish from Bayou d'Inde that contain bioaccumulative COCs such as mercury, TCDD-TEQs, and total PCBs (Aroclors). The mean PEC-Q predictive model does not include mercury and TCDD-TEQs, and includes PCBs as one of multiple compounds affecting the mean PEC-Q value. Therefore, the approved remedial standard includes a supplemental evaluation of mercury, TCDD-TEQs, and total PCBs (Aroclors) in sediments. These bioaccumulative COCs are often co-located in sediment with the COCs incorporated in the mean PEC-Q predictive model; however, there may be instances where they are not co-located.

Step 5 of the approved remedial standard focuses on evaluating the degree to which potential response actions implemented in specific areas of the Site, as identified in Steps 1 through 4 of the Preliminary RS process (based on the mean PEC-Q predictive model),

also will result in the reduction of mercury, TCDD-TEQ, and total PCBs (Aroclors) in prey organisms ingested by aquatic-dependent wildlife and human receptors. Reductions in the concentrations of the primary bioaccumulative COCs in the tissues of prey organisms will reduce the level of exposure and risk to aquatic-dependent wildlife and humans. If response actions completed in those areas identified in Steps 1 through 4 (i.e., areas that pose the highest estimated incremental risks to the aquatic organisms, as identified using the mean PEC-Q predictive model) do not also reduce exposure to aquatic-dependent wildlife and humans to acceptable levels, then Step 6 of the approved remedial standard identifies additional areas in which response actions reduce overall exposure/risks to these receptor groups.

Overall, Steps 5 and 6 are concerned with evaluating the degree to which sediment-based remedial activities that reduce concentrations of mercury, total TEQ, and PCBs result in risk reductions to aquatic-dependent wildlife and humans. These two receptor groups are exposed to the constituents of interest not through direct contact with sediments, but through ingestion of prey items and seafood that have accumulated these constituents through trophic transfer from sediments to tissues. In order to complete Steps 5 and 6, it is necessary to estimate the reduction in tissue concentrations of prey organisms and seafood that is anticipated to result from sediment-based remedial activities. The overall reduction in risk to piscivorous birds, mammals, and humans that is anticipated to result from the reduction in the TDI for these receptor groups is then evaluated.

The site-specific probabilistic risk assessment tools used by EPA in the BERA and HHRA are used to evaluate the degree to which predicted percentage reductions in prey item tissue concentrations of COCs would reduce exposure of the aquatic-dependent wildlife and human receptor groups. The following discussion provides a summary of the approach. A detailed discussion can be found in Appendix G to this report.

2.4.2.1 Aquatic-Dependent Wildlife

Potential risk reductions for the aquatic-dependent wildlife receptor group are evaluated as follows. First, based on an assessment of sediment/tissue relationships and home ranges of various prey classes completed in the Bayou d'Inde Study Area

using RI data (refer to Attachment A to the Technical Memorandum, Anchor 2005a and Appendix G to this report), a percent reduction in the SWA mercury, total TEQ, or PCB concentrations in sediments on an AOI- or Site-wide basis is converted to a percent reduction in the tissue concentrations of prey classes, and by extension the TDI, for piscivorous birds and mammals. This conversion from a sediment-based SWA concentration basis to a tissue basis takes into consideration measured sediment/tissue correlations and home ranges for the various prey classes used in the BERA.

These percent reductions in TDI are then entered into EPA's site-specific probabilistic risk models for these receptors (MacDonald Environmental Sciences Ltd. 2002), and the models calculate the percent reduction in risk to these receptors (i.e., the reduction in the probability of exceedance of a dose threshold). Finally, the post-remedy distribution of sediment concentrations of mercury, total TEQ, and PCBs in all the AOIs are evaluated to determine whether there remain any large contiguous areas of elevated sediment concentrations for these constituents that may result in unacceptable conditions with respect to exposure to birds and mammals that forage exclusively in these areas.

For piscivorous birds, EPA concluded that estimated incremental risks due to exposure to mercury and total TEQ are at the low end of the indeterminate risk range. For this receptor, the risk reduction goal is to implement sediment-based remedial actions that will result in a measurable reduction over time in the tissue concentrations of mercury and total TEQ in the prey classes consumed by piscivorous birds, as outlined above. These reductions in prey tissue concentrations are intended to reduce risks to piscivorous birds even further into the lower end of the risk continuum.

For piscivorous mammals, EPA concluded that risks due to exposure to PCBs are in the high risk range. For this receptor, the risk reduction goal is to implement sediment-based remedial actions that will result in a measurable reduction over time in the tissue concentrations of PCBs in the prey classes consumed by piscivorous mammals. These reductions in prey tissue concentrations are intended to reduce

risks to piscivorous mammals. Risk reduction for exposure to PCBs, however, is uncertain. Large percentage reductions in SWA total PCB (Aroclors) concentrations throughout the Site are difficult to attain, because existing PCB concentrations in sediments are already relatively low (i.e., the Site-wide SWA total PCB concentration is approximately 0.24 milligrams per kilogram (mg/kg) and less than 6 percent of the Site sediments have concentrations greater than 0.5 mg/kg.

At sediment sites elsewhere in the United States that are affected by PCBs, remedial actions generally have been limited to areas of PCBs in sediments that exceed concentrations in the range of 0.50 mg/kg to 1.5 mg/kg, although the action level has exceeded 3.0 mg/kg in some circumstances. Typical post-remedy mean or SWA PCB concentration goals (long-term) range from 0.1 mg/kg to 0.25 mg/kg. Total PCB concentrations at the Site are predominantly within these ranges, suggesting that any additional PCB response action may adequately address impacts of this COC to the Site.

A high risk finding for piscivorous mammals is not entirely consistent with an existing Site-wide SWA total PCB concentration in sediment of 0.2 mg/kg. However, fate and transport and exposure conditions within the Site are complex and there may be sources of PCBs to prey organisms that are not captured in the SWA PCB concentration in sediment. For example, sources of PCBs outside of the Site can affect the risk finding since 10 to 20 percent of the assumed diet of piscivorous mammals comprises fish species that likely feed in areas outside Bayou d'Inde. Notwithstanding these uncertainties, Steps 5 and 6 of the approved remedial standard will be used to identify all sediment areas with significantly elevated total PCB concentrations relative to the rest of the Site; any such areas will be managed to reduce associated risks, if feasible. In addition, as noted above, for piscivorous mammals, the lower dose threshold is only approximately a factor of two less than the upper dose threshold. As a result, even relatively modest reductions in the TDI for piscivorous mammals can result in relatively large reductions in risk along the risk continuum.

Moreover, potential reductions in incremental risks caused by exposure to total PCBs likely will be greater than can be quantified directly using the methods described above, because remedial activities recommended for AOI 1 likely will result in the removal of a source of PCBs to sediments and biota downstream of AOI 1. These actions should result in further reductions in PCB concentrations in the tissue of prey organisms consumed by piscivorous mammals. It is not possible to quantify this benefit, however, because it is not known to what degree sediments in AOI 1 contribute to downstream tissue concentrations.

2.4.2.2 *Humans*

EPA concluded that estimated incremental risks to humans caused primarily by ingestion of shellfish from Bayou d'Inde were outside the acceptable risk ranges (Anchor 2005a). Secondary exposure pathways included ingestion of fish from throughout the Calcasieu Estuary. Estimated incremental risks were driven primarily from dioxins/furans and PCBs in shellfish tissue. A small number of other chemical constituents in fish and shellfish tissue also contributed to risk. As discussed in Section 2.1, the HHRA completed by EPA contained a number of assumptions about the way in which people are exposed to contaminated shellfish and fish at the Site that contributed to uncertainty in the overall findings. In addition, the shellfish tissue data set used in the risk assessment was limited both in size and spatial coverage. Notwithstanding these uncertainties, the risk-reduction goal for this receptor class is to implement sediment-based remedial actions that will result in a measurable change over time in the tissue concentrations of dioxins/furans and PCBs in the fish and shellfish from the Site that may be caught and consumed by people. An ongoing biomonitoring program, discussed in more detail in Section 5 of this report, will focus on measuring trends in concentrations of tissues that are consumed by people and comparing tissue concentrations with threshold levels that are used to evaluate the need for seafood consumption advisories in the State of Louisiana. These trends and comparisons will be reviewed annually with the relevant regulatory agencies in the State of Louisiana.

In the future, all measurements of dioxins/furans and PCBs in fish and shellfish tissue will be quantified as total TEQ. As discussed in Appendix G to this report,

total TEQ measurements will incorporate information for both PCBs and dioxins/furans and, therefore, represent an appropriate integrated metric to use to assess the degree of risk reduction for these COCs. Additional information on the total TEQ approach can be found in Appendix G to this report.

3 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

Within each of the four AOIs, existing conditions were evaluated for the purpose of identifying categories of potential remedial alternatives that could be implemented within each AOI to address current and future estimated incremental risk associated with exposure to chemical constituents in sediments. The relevant existing conditions are:

- Physical and biological features and processes
- Site uses and Site access
- Nature and extent of chemical-related sediment impacts
- Estimated incremental ecological and human health risks associated with direct exposure to impacted sediments or exposure through food chain transfer

Based on a review of these conditions, the categories of remedial action considered in the CAS include:

- No Further Action[3]
- Adaptive Management/Biomonitoring
- Monitored Natural Recovery (MNR)
- Sediment Cover
- In Situ Capping
- Removal
- Treatment

No Further Action is an alternative that results in no action being taken to address risks identified in the RI.

Adaptive Management coupled with biomonitoring is a flexible remedial strategy that uses ongoing monitoring to assess the effectiveness of remedial actions that are being incrementally implemented. Biomonitoring is proposed as a means of evaluating the effectiveness of remedial action Site-wide by directly measuring concentrations of COCs in the tissue of certain classes of aquatic organisms at the Site. Additional remedial action can occur if biomonitoring indicates that such action is warranted.

[3] As required by LAC 33:VI.509.C.1.

MNR is a remedial strategy that uses some form of sampling and analysis to confirm the degree to which natural processes that reduce exposure to COCs at the Site are achieving the remedial standard.

Sediment cover involves placing a cover of clean sediment over native sediment in a manner that anticipates some mixing with the native sediment, thereby substantially and permanently lowering concentrations of COCs throughout a shallow mixing zone interval. Because sediment concentrations are reduced when the cover is placed, potential movement of the sediment after the cover is applied does not affect the effectiveness of the sediment cover.

In Situ Capping involves placing clean sediment, other fill, or an engineered material in areas of impacted sediment to provide a chemical isolation barrier between impacted sediment and potential receptors. In situ caps are typically designed to resist erosion from the movement of surface water above the cap.

Removal of sediment involves physically removing sediment from an area of potential exposure to receptors and placing the sediment in an area where the likelihood of exposure of receptors to COCs is reduced.

Treatment involves the use of technologies that immobilize, remove, or destroy contaminants. Few if any effective in situ sediment treatment technologies exist. As discussed in EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA 2005), most sediment that is removed from waste sites is not treated prior to disposal, because most sediment sites exhibit widespread low-level contamination that is difficult and not cost-effective to treat. As discussed further below, these circumstances exist at the Bayou d'Inde site. In addition, the NCP and EPA guidance indicate a preference for treating "principal threat" material; that is, substances in concentrations that are highly toxic or highly mobile (e.g., liquids) and that cannot be safely contained. As discussed later in this section, the chemical constituents of interest at the Bayou d'Inde site do not constitute "principal threat" material and can be safely and reliably contained.

In the following subsections, the existing conditions within each AOI are evaluated to determine the type(s) of remedial actions that are particularly applicable to each AOI. Specific components of the remedial alternatives are also described, along with explanations of why certain remedial alternatives were screened from further consideration for each of the AOIs, where appropriate.

The screening of remedial alternatives was performed using criteria identified in LAC 33:VI.509.C.2. The screening criteria are:

- Effectiveness in achieving the approved remedial standard
- Implementability (both technical, including the availability of construction equipment, and administrative, including the ability to obtain required permits, waivers, or access agreements)
- Infeasible alternatives (basis for elimination)
- Relative cost (basis for elimination if an alternative has a "grossly higher" cost than other alternatives that offer similar effectiveness and implementability)
- Compliance with all Applicable or Relevant and Appropriate Requirements (ARARs)

3.1 AOI 1 Remedial Alternatives

AOI 1 is the portion of Bayou d'Inde upstream (west) of LA-108 (Figure 1-5). This portion of the bayou is approximately 100 to 140 feet wide. The banks are heavily vegetated, with submerged stumps and roots near the banks. In the area of LA-108, Bayou d'Inde is crossed by an above-water pipeline, a low railroad bridge, and the highway itself. The water depth at mid-channel in this portion of AOI 1 varies between 12 and 18 feet. The total area of AOI 1 is approximately 31 acres. The RI identified an area with relatively higher concentrations of PCBs near the downstream end of AOI 1. This downstream 3,000 foot area of AOI 1 was evaluated in the CAS as an area that could potentially require remedial action.

The extent of PCB contamination associated with the two RI samples in the 3,000-foot area was further delineated for the CAS in accordance with the approved Work Plan and Work Plan Addendum (Anchor 2004, 2005b, and 2005c). Additional sediment samples were collected in November 2005 upstream and downstream of the two sampling locations in the RI that had the highest concentrations of PCBs. The purpose of this sampling was to

identify in greater detail the vertical and lateral extent of potential PCB-impacted sediment in the area with elevated PCB concentrations. Additional sediment cores were collected in 2007, in accordance with the approved Supplemental Sampling and Analysis Plan (SAP; Anchor 2007). The additional samples were used to characterize the cross-channel extent of PCB-impacted sediment in the downstream area of impacted sediment. The investigation of AOI 1 is described in Appendix A. The two sets of samples taken for the CAS are separated into an upstream grouping (nine sediment cores—locations BD11 through BD15 and BD18 through BD21 in Figure 3-1) and a downstream grouping (16 sediment cores—locations BD06 through BD10, BD16, BD17, BD22 through BD29, and BD50 in Figure 3-1).

PCB concentrations in the downstream 3,000 foot area are higher than PCB concentrations in the majority of AOI 1, where PCBs were mostly not detected. Because of the limited size of the area of elevated PCB concentrations relative to the total area of AOI 1, it does not significantly affect the SWA PCB concentration (0.308 mg/kg) for AOI 1. The SWA mean PEC-Q for AOI 1 based on RI data is 0.47, which can be attributed largely to the elevated PCB concentrations in the downstream 3,000 foot area. Moreover, even within the area of elevated PCB concentrations, the average (geometric mean) total concentration of PCBs in the 0 to 1-foot (0 to 30-centimeter [cm]) interval based on the CAS samples is 0.28 mg/kg in the upstream grouping and 1.1 mg/kg in the downstream grouping.

Remedial alternatives were developed for AOI 1 to address the sediments with PCB concentrations that contribute to the elevated SWA mean PEC-Q value on an AOI-wide basis. As discussed in Section 2.4.1 of this report, elevated mean PEC-Q values are correlated with incremental risk to the aquatic organisms receptor group. In addition, as discussed in Section 2.4.2., these areas of highest PCB concentrations may also act as sources of PCBs to downstream sediments and biota and may contribute to the estimated incremental risks to piscivorous aquatic wildlife and humans. Mercury and dioxin/furan TEQs are not a focus of remedial alternatives in AOI 1 because the concentrations of these COCs in the sediments of AOI 1 are approximately an order of magnitude lower than in the other AOIs, and do not contribute measurably to estimated incremental risks associated with exposure to sediments. Remedial alternatives using MNR, capping, and removal were developed in addition to No Further Action. The remedial alternatives developed for AOI 1 are described in Sections 3.1.1 to 3.1.5 and summarized in Table 3-1.

3.1.1 No Further Action in AOI 1

The No Further Action alternative would involve taking no additional steps to mitigate impacted sediment and no additional monitoring of AOI 1. The SWA total PCB concentration in surficial (0 to 1-foot interval) sediment leads to a SWA concentration mean PEC-Q value (0.47) in AOI 1 that is in the indeterminate risk range (between 0.33 and 0.56) as defined in the BERA. Surficial PCBs may also act as ongoing sources to downstream areas; therefore, the current conditions do not meet the approved remedial standard. Although the No Further Action alternative would fail to meet the approved remedial standard, it is retained through the screening process and considered in the detailed evaluation of remedial alternatives as a basis for comparison as required by LAC 33:VI.509.C.1 and the National Contingency Plan (NCP), 40 CFR 300.430(e)(6).

3.1.2 Monitored Natural Recovery in AOI 1

The vertical distribution of PCB concentrations in sediment cores collected for the CAS suggests that ongoing natural sedimentation processes may be reducing concentrations of PCBs in shallow sediment in AOI 1. Of the 25 sediment cores collected during the CAS-related sampling in AOI 1, 15 cores contained total PCB concentrations in the 0 to 1-foot interval that were less than the total PCB concentrations in one or more of the deeper samples. These results suggests there is ongoing deposition of sediment and that the more recent (i.e., shallower) sediment is relatively unimpacted by PCBs. Of the 10 cores that did not have lower concentrations in the 0 to 1-foot interval, four cores (sample locations BD16, BD20, BD21, and BD22) contained very low concentrations of PCBs in all depth intervals.

The MNR alternative involves monitoring the shallow sediment to demonstrate a reduction in the concentration of PCBs over time. A baseline would be established by collecting surface sediment grab samples from the impacted area of AOI 1. The samples would be analyzed for PCB congeners. Subsequent monitoring would involve collecting surface grab samples in essentially the same locations using the same collection methods and analyzing the samples for the same constituents. The cost estimate for the AOI 1 MNR remedial alternative was developed assuming that monitoring would include collecting samples annually for 5 years and then once every 5 years thereafter for a total of 30 years (for a total of 10 rounds of sampling), although the sampling schedule could

be modified with LDEQ approval if the results of the monitoring indicated that more or less monitoring was needed, or if some disturbance of the sediment was suspected due to a change in flow conditions or some other event. This alternative would also involve implementing administrative controls, such as posting signs advising against dredging or disturbing sediment in the impacted area. There are no ARARs associated with implementing the AOI 1 MNR remedial alternative.

3.1.3 Sediment Removal/In Situ Capping in AOI 1

The Removal/In Situ Capping alternative for AOI 1 would involve dredging 2 feet of sediment from the impacted area between BD23 and BD16 (i.e., most of the downstream grouping; Figure 3-2) and placing a cap over the same area. As already discussed, the most highly impacted sediment is in the downstream grouping; this alternative would address the most impacted surficial sediment area in AOI 1. Figure 3-3 shows the vertical extent of sediment removal in selected cross sections. The purpose of the 2-foot removal prior to capping impacted sediments is to maintain water depths and the hydraulic capacity of the channel. The dredging would remove a significant portion of the PCB-impacted sediment, and would lower the average (geometric mean) PCB concentration in the downstream grouping from 1.1 mg/kg to approximately 0.18 mg/kg, even before placement of a cap over the remaining sediments in the dredging footprint. The cap would provide a barrier between potential receptors and the impacted sediment that is left in place and would prevent potential resuspension and downstream transport of impacted sediment. The in situ cap would consist of an erosion resistant layer of gravel placed on top of a layer of sand, which would prevent the gravel from sinking into the fine-grained native sediment. The post-capping surficial PCB concentrations are assumed, for evaluation purposes, to be equal to the lowest detected PCB concentrations measured anywhere in AOI 1.

Approximately 18,500 cubic yards (cy) of sediment would be removed from AOI 1 in this alternative. Several options were considered for managing the dredged sediment. The dredged sediment could be:

- Dewatered and staged at a temporary storage facility built for the alternative and taken to an off-site landfill by truck.

- Treated in a temporary treatment system set up adjacent to Bayou d'Inde, with treated sediment used as fill, where needed, at one of the Bayou d'Inde Group members' facilities (treatment residuals, if any, would be disposed of off-site).
- Treated in a temporary treatment system set up adjacent to Bayou d'Inde, with treated sediment used as capping material within the AOC (treatment residuals, if any, would be disposed of off-site).

The effectiveness of several treatment technologies in removing PCBs from sediment (soil washing) or destroying the PCBs (chemical and biochemical treatment) has been evaluated over the past several years and has achieved varying degrees of success. The rate (tons of sediment per day) at which sediments may be successfully treated to remove PCBs have been projected from laboratory studies and in all cases there is a lengthy treatment time interval. These treatment rates are considerably lower than the slowest practical rate at which sediment would be dredged from AOI 1 even if the smallest equipment were used for dredging. Because the treatment process would not be able to treat sediment as quickly as it is dredged, additional upland space would be needed to store sediment or to accommodate additional treatment units. The applicability of treatment for remedial action in AOI 1 is discussed in the remedial alternatives screening discussion in Section 3.1.6.

The ARARs associated with the Removal/Capping remedial alternative are related to maintaining water quality during dredging and capping operations and maintaining the hydraulic capacity of the channel. None of the ARARs would pose an insurmountable challenge to implementing the Removal/Capping remedial alternative in AOI 1.

3.1.4 Sediment Removal/Backfilling in AOI 1

The Sediment Removal/Backfilling alternative for AOI 1 would involve removing sediment characterized in the PCB delineation study in both the upstream and downstream segments. Although the vertical extent of impacted sediment was not fully defined in the RI or the CAS sampling, costs for this alternative were developed assuming that 5 feet of sediment would be removed between locations BD21 and BD20 and between locations BD23 and BD16. Figure 3-4 shows the lateral extent of sediment

removal and Figures 3-5 and 3-6 show the vertical extent of sediment removal in selected cross sections.

Approximately 47,000 cy of sediment would be removed from AOI 1 in this alternative. Steel sheetpile may be driven along the top of the bank to maintain bank stability during the removal. After the removal, the channel would be backfilled to approximately the current bathymetry to stabilize the bank. The management options for the dredged sediment are similar to those presented in Section 3.1.3, with the addition of the option of using the treated sediment as backfill in AOI 1. The ARARs associated with the Removal/Backfilling remedial alternative are the same as those for Removal/Capping and would not pose an obstacle to implementing this remedial alternative.

3.1.5 In Situ Capping

In Situ Capping without sediment removal can be implemented without any significant reduction in the cross-sectional area of the channel if an engineered cap material, such as articulated block mat (ABM), is used. This is a result of the thin profile of the ABM. A relatively thin layer (6 inches or less) of this engineered cap material can achieve effectiveness similar to that of more than a foot of granular material, primarily because of the size and density of the blocks. Larger, heavier capping material provides greater resistance to erosion and a more continuous solid cap surface than caps made with finer materials. The layers of geotextile in ABM also contribute to containing contaminated sediment. ABM and related materials have been used for years for erosion control and sediment capping. One installation of ABM close to the Site, in the PPG Canal, has been in service without problems and with little sign of wear for 15 years. While the material is more expensive to purchase than granular capping materials, it has several advantages for certain applications compared to sand and gravel caps, including:

- It is not subject to being transported downstream during placement
- It will not mix with native sediment
- It cannot be resuspended by currents after placement
- It is more resistant to penetration by burrowing benthic organisms.

In situ formed concrete mats consist of two layers of woven geotextile, sewn together in a grid pattern. The fabric is placed in the desired location, anchored in place, and then

filled with a cement grout. Several types of in situ formed concrete mats are available, two of which are well suited to conditions in AOI 1. Uniform section mat (USM) provides a cap of approximately uniform thickness over the entire area where it is installed. The USM cap forms to the existing contours when the fabric is placed, but it is inflexible once the cement grout cures. ABM provides a flexible, multilayer cap that can form to the contours of the underlying material even as the native sediment settles after the cap is installed. The completed ABM cap consists of blocks of concrete encased in and joined by layers of geotextile. Synthetic cable between the layers of geotextile becomes embedded in the cement grout and provides reinforcement of the finished product after the grout cures. The USM and ABM materials are illustrated schematically in Figure 3-7.

The In Situ Capping remedial alternative would involve placing an ABM cap over the impacted area. This alternative was evaluated for two options, including:

1. Option 1 – Capping the downstream area (approximately 17,000 square yards) depicted in Figure 3-2
2. Option 2 – Capping the full area encompassing both the upstream and downstream impacted areas depicted in Figure 3-8 and the area between the upstream and downstream segments (approximately 36,300 square yards)

In both options, the cap would be anchored at the top of the banks on both sides of Bayou d'Inde. All in situ capping alternatives would also include implementing administrative controls so that no significant disturbance of the in situ cap occurs. The ARARs associated with the In Situ Capping remedial alternative are the same as those for Removal/Capping and would not pose an obstacle to implementing this remedial alternative.

3.1.6 Screening of Remedial Alternatives for AOI 1

The screening of remedial alternatives for AOI 1 is summarized in Table 3-2. The effectiveness of the remedial alternatives is directly related to the physical characteristics of the AOI and the COCs. The COCs for AOI 1 are PCBs, which adhere strongly to sediment and do not dissolve into the water column to a significant degree. Therefore, remedial alternatives that contain or remove the affected sediment will effectively

address the remedial standard. The effectiveness of capping technologies is determined by the ability of the capping material to block the exposure pathway between contaminated sediment and receptors and to prevent resuspension and transport of contaminated sediment. The most significant implementability considerations for all of the remedial alternatives except No Action and MNR are the potential to resuspend contaminated sediment during construction, the ability to control the transport of such sediment, and the ability to maintain the stability of the banks of the bayou. Less intrusive technologies are less likely to resuspend sediment and therefore present lower short-term risks. For alternatives that would involve removal and off-site disposal, a significant implementability consideration would be the need to site a staging, dewatering, and truck-loading facility adjacent to the bayou.

Removal and capping or backfilling were considered in combination in two of the remedial alternatives, both of which are carried through to the detailed evaluation of remedial alternatives in Section 4.1 for the reasons set forth in Table 3-2. In Situ Capping (without removal) was also considered for both the downstream impacted segment of AOI 1 and a larger area encompassing both impacted segments. Both In Situ Capping options are carried through to the detailed evaluation of remedial alternatives, for the reasons set forth in Table 3-2.

Removal of sediment by itself was not developed as a stand-alone remedial alternative for AOI 1. Removal of the full vertical extent of PCB contamination would destabilize the banks of the channel beyond the limits of practicable engineering controls, such as the steel sheet piling evaluated for bank stabilization in the 5-foot removal in the Removal/Backfilling remedial alternative. If the banks could not be stabilized through practicable engineering controls, they would effectively need to be removed as well, by laying back the sides of the excavation, widening the bayou, and impacting currently unaffected property.

Both off-site disposal (without treatment) and on-site treatment were considered in this screening for the management of dredged sediment. Off-site disposal, while costly, would effectively remove the impacted sediment from the Site and is implementable.

Treatment of removed sediment is not considered further in this CAS. Destruction of PCBs in sediment has been demonstrated to some degree in the laboratory with multiple treatment phases, but the technology has not been shown to be effective or reliable in full-scale operation and has not been applied to full-scale remedial action for sediment. As noted in Section 6.7 of EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA 2005), most sediment removed from waste sites is not treated prior to disposal, because most sediment sites exhibit widespread low-level contamination that is difficult and not cost-effective to treat. The NCP and EPA guidance indicate a preference for treating "principal threat" material; that is, substances that are highly toxic or highly mobile (e.g., liquids) that cannot be safely contained. For PCB sites, "principal threat" material is generally material that contains over 100 to 500 parts per million (ppm) PCBs. See 40 CFR 300.430(a)(1) *Guidance on Remedial Actions for Superfund Sites with PCB Contamination* (EPA 1990). PCB concentrations in AOI 1 are considerably below those associated with "principal threat" material. In addition, materials with lower concentrations of PCBs can generally be safely and reliably contained over the long term. Because PCBs adhere strongly to sediment particles, rather than dissolving in water, PCBs in removed sediments can be readily controlled by containment.

Moreover, as discussed in Section 3.1.3, the implementation of on-site treatment technologies would require clearing a large area adjacent to AOI 1 for untreated sediment, treatment equipment, and storage of treated sediment prior to replacement in the AOI. The amount of space required for these activities, over and above the space required for staging dredging and offloading activities, is not readily available near the AOI, rendering on-site treatment unimplementable. Off-site treatment would add more than $10 million to the cost of the remedy. For all of these reasons, treating the dredged sediment (other than dewatering) would not be effective, implementable, or cost-effective, and treatment of sediment was screened from consideration in the detailed evaluation of alternatives.

The remedial alternatives retained for detailed evaluation for AOI 1 are:

- No Further Action
- Monitored Natural Recovery

- Removal/Capping
- Removal/Backfilling
- In Situ Capping (Option 1)
- In Situ Capping (Option 2)

3.2 AOI 2 Remedial Alternatives

AOI 2 is the portion of the Bayou d'Inde main channel between LA-108 and the mouth of Bayou d'Inde at the Calcasieu River Ship Channel (Figure 1-5). The length of this portion of Bayou d'Inde is approximately 23,350 feet. The width of the bayou in AOI 2 ranges from approximately 140 feet to nearly 300 feet, and its mid-channel depth ranges from 12 to 14 feet. The total area of AOI 2 is approximately 100 acres. This portion of Bayou d'Inde is actively used for tug and barge traffic, which requires the full depth of the channel for navigation. The movement of tugs and barges can resuspend sediment in AOI 2 because of the draft of the vessels relative to the depth of the channel and the forces induced on the bottom of the channel by the hull of the barges and the propeller wash of the tugs.

The SWA mean PEC-Q in AOI 2 is 0.30 based on data collected in the RI (CDM 2003). . Mean PEC-Q values are interpolated from the RI data in Figure 2-1. EPA has characterized mean PEC-Q values below 0.33 as low risk, as discussed in Section 2 of this report. As shown on Figure 2-1, most of the sample locations exhibit a mean PEC-Q value in the range of 0.2 to 0.39. These values are either "low risk" as defined by EPA, or in the lower end of the "indeterminate risk" range for aquatic organisms.

According to the RI data, dioxin/furan TEQ values (Figure 2-4) in two non-contiguous portions of the lower 5,600 feet of AOI 2 are elevated compared to the values in the rest of AOI 2 and may act as sources to biota in this portion of the Site. Additional sediment samples were collected in this portion of AOI 2 in 2007 to further delineate the horizontal and vertical distribution of TEQ concentrations in sediment. The supplemental sampling in AOI 2 is presented in Appendix E. Higher TEQ concentrations were found in the shallow sediment in the middle of the channel. TEQ concentrations in surface sediment in lower AOI 2 and the PPG Canal are presented in Figure 3-9. The SWA mercury and PCB concentrations in the sediments of AOI 2 are generally lower than the SWA concentrations in the other AOIs, except for mercury in AOI 1, and therefore are not a primary focus of

remedial alternatives in this AOI. However, mercury and PCBs are elevated in the lower 5,600 feet of AOI 2 compared to the values in the rest of AOI 2, and may act as sources to biota in this portion as well.

The evaluation of AOI 2 included the portion of the PPG Canal that was sampled in the RI. The remedial alternatives evaluated for AOI 2 do not include the PPG Canal, as PPG is currently constructing a new canal that will remove the lower 5,000 feet of the current PPG Canal from service and cap the rest of the current PPG Canal. The Lower PPG Canal will be capped as part of PPG's on-site corrective action after it is taken out of service.

Remedial alternatives were developed for AOI 2 primarily to address the potential human health risks associated with ingestion of total TEQ-impacted seafood (fish and shellfish) caught in AOI 2. These alternatives also address potential risks to wildlife due to exposure to mercury, total TEQ, and PCBs in prey items.

The remedial alternatives developed for AOI 2 are No Further Action, Adaptive Management/Biomonitoring, and Sediment Removal. In Situ Capping is inappropriate for AOI 2 as a stand-alone remedial alternative because any further reduction in water depth by capping materials may impede commercial barge traffic and restrict drainage in this portion of Bayou d'Inde. As the COCs present in AOI 2 are not amenable to biodegradation, the success of MNR in this AOI would depend on deposition of clean sediment. Vertical TEQ concentration profiles (peak TEQ concentrations appear at or near the sediment surface in several core locations) suggest that the natural deposition of additional sediment in this portion of AOI 2 would be ineffective in significantly reducing TEQ concentrations. The corrective action alternatives developed for AOI 2 are described in Sections 3.2.1 through 3.2.3 and summarized in Table 3-3.

3.2.1 No Further Action in AOI 2

The No Further Action alternative would involve taking no steps to mitigate the potentially impacted sediment and no monitoring of AOI 2. The SWA mean PEC-Q value and the SWA mercury and PCB concentrations indicate that No Further Action may be appropriate for all of AOI 2. However, the elevated dioxin/furan TEQ concentrations suggest that remedial action may be warranted in the lower portion of

the AOI. The No Further Action alternative is retained through the screening process and considered in the detailed evaluation of remedial alternatives as a basis for comparison as required by LAC 33:VI.509.C.1.

3.2.2 Adaptive Management/Biomonitoring in AOI 2

The Adaptive Management/Biomonitoring alternative would involve taking no remedial action immediately in AOI 2 other than continued biomonitoring, pending evaluation of the overall success that other remedial actions completed throughout the Site and elsewhere in the Bayou d'Inde drainage area (e.g., the PPG Canal) achieve in terms of reducing concentrations of total TEQ in fish and shellfish tissue collected from AOI 2. These other remedial actions, which include the management of contaminated sediments in AOI 1, AOI 3, AOI 4, and the PPG Canal, will remove or reduce sediment concentrations that may act as sources of PCBs and dioxins/furans (i.e., total TEQ) to biota in AOI 2. Implementation of the proposed remedial actions in these other areas may demonstrate that remedial action in AOI 2 would be ineffective and unnecessary. The biomonitoring program discussed in Section 5 would be designed, in part, to assess ongoing changes in total TEQ concentrations in fish and shellfish tissue collected from AOI 2. The Adaptive Management alternative would allow the consideration of additional remedial actions if the results of the biomonitoring suggest that additional action may be warranted.

3.2.3 Sediment Removal in AOI 2

Two Sediment Removal alternatives were developed for AOI 2, involving the removal of different amounts of sediment from AOI 2 with the primary goal of lowering the tissue dioxin/furan TEQ values in fish and shellfish irrespective of other remedial actions in AOI 1, AOI 3, and AOI 4. The removal areas for Option 1 are shown in plan view in Figure 3-10. Based on the results of sampling performed for the RI, the post-Hurricane Rita Assessment (Anchor 2006a), and the supplemental CAS sampling (Appendix E), Sediment Removal Option 1 involves removing approximately 42,000 cy of sediment from AOI 2 in the areas of highest known TEQ concentrations (Figures 3-10 and 3-11). Sediment would be removed from these areas over a total length of approximately 2,500 feet.

The actual area and depth of sediment removal may be refined in the remedial design phase. The depth of dredging in most of the removal area would be approximately 1 foot with a 1-foot overdredge allowance. Typical cross sections for the Option 1 removal are shown in Figure 3-12. In the areas of deeper impacted sediment (at sampling locations BD34, BD44, and BD48), the depth of the dredge cut would be increased as shown on Figures 3-10 and 3-12. Table 3-4 shows the measured TEQ concentrations in the area to be dredged as well as the proposed dredging depths at each location to illustrate the TEQ concentrations in the sediment to be removed.

Removal Option 2 is more extensive and would restore the channel to the previously dredged limits, as close as can be ascertained from as-built survey records from 1959 and 1967. The highest concentrations of dioxin/furan TEQ and PCBs observed in the RI and Supplemental CAS samples from this area are within the proposed dredge prism in this alternative for all depth intervals (Figure 3-11). The dredged channel would be widened from 78 feet to 150 feet near the mouth of Bayou d'Inde to facilitate entry into the channel and to capture an area where elevated TEQ concentrations were found farther from the centerline of the channel. The Option 2 removal is illustrated in plan view in Figure 3-13 and in cross sections in Figures 3-14 and 3-15.

Sediment Removal Option 2 involves removing approximately 97,000 cy of sediment from AOI 2 as indicated on Figure 3-13. The area that would be dredged includes approximately 5,600 feet from the mouth of Bayou d'Inde upstream nearly to the mouth of the PPG Canal. The width of the proposed removal area is approximately 78 feet, which is the width of the channel dredged previously, except in the lower 840 feet of the channel, where the width would be increased to 150 feet. The channel would be dredged to approximately -15 feet National Geodetic Vertical Datum (NGVD) as documented in the as-built survey from the 1967 dredging event. Typical cross sections of the presumed dredge prism are shown on Figures 3-14 and 3-15. The cross sections reflect 1:1 (horizontal to vertical) side slopes, which may be stable in the short-term while dredging is underway and were used to estimate volumes of sediment to be dredged. Measured TEQ concentrations in the area to be dredged are shown on Table 3-5 along with the proposed dredging depths to illustrate the TEQ concentrations in the sediment to be removed.

For either Sediment Removal alternative, the options for managing the dredged sediment include:

- Consolidating the sediment within a relatively isolated part of AOI 4 and isolating it from potential receptors with a cover of clean sediment or sand
- Dewatering and staging at a temporary facility built for the alternative or at an existing commercial facility and taken to an off-site landfill (either a commercial landfill or a new landfill, permitted and developed specifically for this project) by truck

The ARARs associated with the Removal remedial alternative are related to maintaining water quality while dredging sediment from AOI 2, placing the sediment in AOI 4, and placing the cover in AOI 4 (for the on-site management option). For the off-site disposal option, regulations for siting, permitting, and operating a solid waste landfill would apply as would requirements for trucking the material. None of the ARARs for the options of on-site management or off-site disposal at a commercial facility would pose an insurmountable challenge to implementing the Removal alternative in AOI 2, although permitting a new landfill (off-site disposal in a project-dedicated facility) would be more challenging and time consuming.

3.2.4 Screening of Remedial Alternatives for AOI 2

The screening of remedial alternatives for AOI 2 is summarized in Table 3-6. As explained in Section 3.2, MNR and In Situ Capping were not developed as stand-alone remedial alternatives for AOI 2. As peak TEQ concentrations still appear at or near the sediment surface in several core locations, natural deposition of sediment does not appear to be effectively reducing concentrations in the biologically available zone, which would be the mechanism for effective MNR in AOI 2. The limited water depth and frequent barge traffic in AOI 2 is inconsistent with In Situ Capping, which would reduce water depth and potentially exacerbate drainage and navigation limitations in this portion of Bayou d'Inde. The Adaptive Management/Biomonitoring alternative is not retained for consideration in the detailed evaluation of alternatives because of the uncertainty in the ability of this alternative to effectively achieve the approved remedial standard in an acceptable time frame. This uncertainty is driven primarily by the

presence of elevated levels of TEQ concentrations in sediment, as determined during the 2007 supplemental sampling in lower AOI 2 (Appendix E). Higher TEQ concentrations were found in the shallow sediment in the middle of the channel. As TEQ concentrations tend to be highest in the shallowest sediments in this area, ongoing deposition of sediment does not appear to be reducing TEQ concentrations to levels that would be protective. Both Sediment Removal options were retained for consideration in the detailed evaluation.

Both the on-site and off-site options for managing sediment from AOI 2 were retained for detailed evaluation for the sediment removal alternatives. Both options could effectively isolate COCs from potential receptors, and both options are implementable although they have associated challenges. Sediment removed from AOI 2 could be effectively contained within isolated areas of AOI 4. The on-site option (consolidation of sediment within a contained portion of AOI 4) would require approval from the landowner (PPG) for this purpose. Existing roads provide isolation from open waters and could be supplemented with new earthen levees. Recent construction activities by PPG in Lockport Marsh have demonstrated the feasibility of constructing sidecast levees in this setting for controlling sediment and controlling the discharge of water from the placement of hydraulically dredged sediment. Appropriate engineering evaluations would be required as part of the design to locate oil wells and pipelines and to identify methods for protecting or moving these items. A review of historical water level measurements by NOAA in Lake Charles indicates that surface water levels rarely (less than 0.5 percent of measurements since 2002) rise above 2.0 feet NGVD, an elevation to which the existing roads could be feasibly raised. This would require a maximum increase in elevation of 1 to 2 feet in some places. After consolidating AOI 2 sediment in AOI 4, it would be covered with clean sediment as is discussed as a remedial alternative for AOI 4 in Section 3.4. In addition, data collected for CAS and reported in Appendix B indicate that sediments within AOI 4 are stable and critical shear stresses are rarely exceeded (less than 0.2 percent of the time).

Because dioxins/furans and PCBs adhere strongly to sediment particles, rather than dissolving in water, dredged sediments can be readily controlled by containment. For the same reasons as discussed in detail in Section 3.1.6 for sediments removed from AOI

1, the implementation of on-site treatment technologies for treatment of sediments removed from AOI 2 would not be effective, implementable, or cost-effective, and treatment of sediment was screened from consideration in the detailed evaluation of alternatives.

The off-site disposal option would require siting and developing a facility for dewatering dredged sediment and transferring it to trucks for transportation to the disposal facility. The option of developing a new landfill would require purchasing property and permitting, developing, and operating a new landfill.

The remedial alternatives retained for detailed evaluation for AOI 2 are:

- No Further Action
- Sediment Removal (Option 1)
- Sediment Removal (Option 2)

3.3 AOI 3 Remedial Alternatives

AOI 3 comprises the "fringe marshes" adjacent to the Bayou d'Inde main channel from LA-108 downstream to the upstream boundary of Lockport Marsh (Figure 1-5). Most of these "marshes" are actually areas of shallow open water that are surrounded by dense vegetation. Occasional gaps in the banks of Bayou d'Inde connect the fringe marshes to the main channel. The total area of AOI 3 is 145 acres. The SWA mean PEC-Q value for AOI 3 is 0.49.

A vegetation survey was performed in April 2006 to identify the types of vegetation that are present in AOIs 3 and 4, the location of the vegetation, and the elevation where vegetation occurs relative to the water level. The results of the vegetation survey are presented in Appendix C. An important finding from the vegetative survey is that there are numerous existing areas within the Site where healthy emergent marsh habitat exists. This habitat is found along the perimeters of the fringe marshes and on the banks that partially separate the marshes from the Bayou d'Inde main channel The limiting factors for the establishment of additional emergent marsh habitat appear to be elevation (+1.0 to +1.5 ordinary high water level is a preferred elevation) and substrate (silty clay substrate is preferred).

The fringe marshes provide shallow water habitat with shade and cover around the peripheries of the marshes and among the stumps and roots within the marshes. Access to and within the fringe marshes by construction equipment would be significantly hampered by the shallow water depths and the presence of dense living vegetation and numerous stumps and roots.

Remedial alternatives were developed for AOI 3 to reduce the SWA mean PEC-Q value (and, by extension, the SWA PCB concentration), the SWA mercury concentration, and the SWA dioxin/furan TEQ concentration. Remedial alternatives using MNR and capping were developed in addition to No Further Action. Removal was not considered for AOI 3 because of the significant implementability issues associated with gaining access to the fringe marshes, relocating pipelines and other possible structures, and removing sediments from areas with numerous stumps and other debris. In addition, a removal alternative in AOI 3 would cause substantial habitat destruction. Specifically, numerous areas of healthy emergent marsh habitat mapped during the vegetative survey (Appendix C) would be impacted as a result of the need for Site access to relocate pipelines, remove stumps and other debris, and to mobilize and operate dredging equipment. These habitat areas have existed for approximately 40 years (since the last dredging of Bayou d'Inde in 1967) and are extensively utilized by aquatic-dependent wildlife and fish. Because some of the impacted sediment areas are along shorelines in very shallow water and these areas also contain numerous stumps and other debris, some removal activities would be land-based and would require the construction of access roads and the clearing of these productive vegetated areas to create staging areas and locate and operate excavation and removal equipment.

The highest mean PEC-Q values found in AOI 3 occur in the fringe marshes in the western and central portions of AOI 3 (Figure 2-1). The primary contributor to the mean PEC-Q in these areas is total Aroclor PCBs with concentrations between 1.0 and 1.8 mg/kg (Figure 2-3). The highest mercury concentrations (5.8 to 12 mg/kg) are in three of the easternmost fringe marshes (Figure 2-2). These areas may contribute to estimated incremental risks to aquatic-dependent wildlife throughout the Bayou d'Inde Study Area. The mean PEC-Q concentrations in these three marshes are lower than in the central marshes. Dioxin/furan TEQ concentrations are generally higher in the eastern portion of AOI 3. Two scenarios of

varying remedial action areas were evaluated to arrive at the greatest reduction in the SWA mean PEC-Q value, SWA total PCB concentration, SWA mercury concentration, and SWA dioxin/furan TEQ concentrations, while causing the least disruption of existing fringe marsh habitat. Additional reductions in SWA concentrations would require a disproportionate amount of additional cover and would result in a disproportionate amount of habitat disruption due to increasingly difficult access issues in more remote areas of the fringe marshes. Areas associated with the two scenarios are shown on Figure 3-16.

The approximate vertical extent of impacts to sediment in AOI 3 was evaluated using data from sediment cores BD04 and BD05 (shown on Figure 3-16). The chemical data are presented in Appendix B. In summary, the observed impacts are limited to the upper 1.0 to 1.5 feet of sediment. The mean PEC-Q values below this depth are representative of background conditions and are in the low risk range, as are concentrations of dioxin/furan TEQ, mercury, and PCBs.

The corrective action alternatives developed for AOI 3 are described in Sections 3.3.1 through 3.3.3 and summarized in Table 3-7.

3.3.1 No Further Action in AOI 3

The No Further Action alternative would involve taking no steps to mitigate impacted sediment and no monitoring of AOI 3. The SWA mean PEC-Q values in surficial (0 to 1-foot interval) sediment is 0.49, which is near the upper end of the indeterminate risk range used by EPA in the BERA. In addition, there are areas within AOI 3 where the mean PEC-Q value is within the high risk range (Figure 2-1). The approved remedial standard calls for reducing the SWA mean PEC-Q values, dioxin/furan TEQ, and mercury concentrations in sediments in AOI 3. Although the No Further Action alternative would fail to meet the approved remedial standard, it is retained through the screening process and considered in the detailed evaluation of remedial alternatives as a basis for comparison as required by LAC 33:VI.509.C.1.

3.3.2 Monitored Natural Recovery in AOI 3

MNR processes were evaluated in the CAS, and field data were gathered from two locations (BD04 and BD05) in AOI 3 (Figure 3-16) to evaluate the potential for physical

natural recovery processes to isolate the impacted sediment or to eliminate or significantly reduce exposure pathways to ecological and human receptors. The MNR evaluations involved the following:

- Sedimentation rates were estimated from analysis of radioisotopes in the sediment column.
- The quality of recent and historically deposited sediment was assessed with whole-sediment chemical analyses.
- The stability of the sediment was assessed using sediment flume testing and surface water velocity measurements.

The evaluations of all of these data are presented in Appendix B. Sedimentation rates are estimated to vary between approximately 0.02 and 0.27 cm/year at BD04, and between approximately 1.0 and 1.1 cm/year at BD05; however, observations of sediment cores at BD05 indicate that anthropogenic influences (i.e., dredging-related deposits) may have artificially increased sedimentation rates in this area.

With respect to sediment chemistry at BD04 and BD05, for some of the chemical constituents of interest, the concentrations detected in the 0 to-2 cm samples were generally lower than the concentrations in the 0 to 11-cm intervals (see Appendix B). This observation suggests that clean sediments coming into the system more recently are slowly covering or mixing with older, more impacted, sediments and reducing the concentrations of many chemical constituents.

Sediment bed stability analyses indicate that sediments in the fringe marshes are hydrodynamically stable. Surface water velocities were recorded at the five sampling locations (BD01 through BD05) at 15-minute intervals beginning in December 2005. Field measurements of velocity from December 2005 through July 2007 showed that surface water velocities rarely (in less than 0.02 percent of the observations at BD04 and BD05 in AOI 3) produced shear stresses required to resuspend and/or scour surface sediments (see Appendix B).

In summary, the concentrations of many chemical constituents are apparently decreasing, albeit slowly, in the most recently deposited sediment in AOI 3, and bed

stability analyses indicate these sediments are likely stable over the long term following deposition. Although low sedimentation rates limit the effectiveness of MNR as a remedial technology for large-scale application in AOI 3, these process are occurring and enhance the protectiveness provided by more active remedial actions.

In addition to natural recovery by clean sediments coming into the system, biochemical processes may reduce PCB concentrations and sequester mercury in sediment. The effectiveness of these processes has not been demonstrated, particularly in shallow waters where dissolved oxygen would inhibit these largely anaerobic processes. There are no ARARs associated with implementing the AOI 3 MNR remedial alternative.

3.3.3 Sediment Cover in AOI 3

Two sediment cover alternatives were developed for AOI 3 using a minimum 6-inch cover over two areas of different sizes (27 and 39 acres). Figure 3-16 shows the lateral extent of the cover for the 27- and 39-acre alternatives. The extent of the cover was selected based primarily on the areas of mercury and mean PEC-Q impacts (and by extension, PCB impacts) described in Section 3.3. Both in situ capping alternatives would include implementing administrative controls so that no significant disturbance of the in situ cap occurs.

Construction of the 6-Inch Cover alternative involves discharging a volume equal to a minimum of 0.5 foot of clean fine-grained material into the previously identified areas of AOI 3 to actively reduce surface concentrations in these areas with minimal disruption of the existing sediment substrate or the existing vegetation and land surrounding the target area. In actual construction, contractors generally place excess cover material to achieve the minimum 0.5-foot cover thickness throughout the area. This excess material is referred to as overplacement. An overplacement allowance of 0.5 feet was assumed in developing the cost estimates for 6-Inch Cover alternatives in the CAS.

Prior to placing cover material, the connection between Bayou d'Inde and the fringe marsh area to be covered would be closed with a temporary levee or sheetpiling. As needed, additional containment would also be provided to contain water and sediment in the fringe marsh during construction. The containment would be completed during

high water to retain water that may otherwise drain from the fringe marshes during construction. Water levels in Bayou d'Inde and the fringe marshes drop considerably during a low tide coupled with a strong north wind. The purpose of containing the water is twofold:

- Increasing the water depth would facilitate the access of equipment to the fringe marshes.
- The containment would be used to control water quality during construction. Water would be released to Bayou d'Inde through a weir during the placement of the cover after the maximum practical amount of suspended sediment had settled in the fringe marsh.

The cover material would be hydraulically dredged from a local source of sediment, such as the Calcasieu River Ship Channel, and discharged into the target areas. If an appropriate local source is unavailable, clean sand from an upland source may be used. The energy of cover placement may cause some mixing of the cover material with the impacted native sediment, although the degree of such mixing would be controlled by raising the water level and by using energy-dissipating devices for placing the cover material. Surface concentrations of COCs would be substantially reduced by the mixing of cover material with native sediment, thereby reducing risk to potential receptors.

Final surface concentrations of chemical constituents may vary depending on the technique used to apply the cover material and the actual amount of cover material applied. In general, greater reductions in surface concentrations would require more time to apply the cover, would cost more, and—if more cover material is applied—would create greater disruptions to habitat and greater loss of storage capacity for flood water. For the purpose of evaluating risk reduction in Section 4 and developing costs for the 6-Inch Cover remedial alternatives, a three-to-one mixing ratio of cover material to native sediment (i.e., a 75 percent reduction in surface concentrations of COCs) was assumed. This assumption is considered achievable based on experience at similar projects and a consideration of the placement technologies and methodologies available to control the placement of the cap material. Cost estimates were developed that are consistent with the cover placement techniques available, and in consideration of the amount of material and time required for cap placement to achieve a 75 percent

reduction in surface concentrations. The anticipated reductions in the SWA mean PEC-Q value and SWA mercury concentration are discussed in Section 4.3.

One anticipated advantage of applying a cover to these shallow areas is to create additional marsh habitat at the Site. Over time, areas of Bayou d'Inde that were formerly shallow upland or marsh have become inundated on a permanent basis due to general trends of rising water levels in these areas. Areas of cover placement that create marsh habitat will promote the overall health of the Bayou d'Inde ecosystem.

At the end of construction, the fringe marsh would be reopened to Bayou d'Inde by removing the temporary containment structure. An assessment of the bed stability of the post-remediation cover was performed by evaluating potential shear stresses that would occur at the surface of the 6-Inch Cover using site-specific velocity measurements at locations BD01 through BD05 (i.e., the evaluation also was performed for sediments in AOI 4) in the MNR evaluation (see Sea Engineering Memorandum, Appendix B). The bed-stability assessment, which is summarized below, concluded that the 6-Inch Cover would be stable in AOI 3 over the long term.

The stability of the cover was evaluated mathematically by estimating the bulk densities and critical shear stresses of the mixture of native sediment and cover materials over time. The evaluation found that the modeled bulk densities and critical shear stresses vary rapidly in the first 7 days during the initial settling of the material after applying the cover, but stabilize considerably after 28 days. The ultimate critical shear stress predicted for the material is approximately 0.41 Newtons per square meter (N/m^2). These predictions are based on native sediment measurements that have biotic activity, gas generation, and large organic material present, all of which may act to increase the erosion rates (i.e., decrease the critical shear stress) of the sediments; therefore, the predictions are likely conservative when compared to uniform cover material placed without these potentially destabilizing factors.

These calculated critical shear stresses for the cover material are very similar to the measured critical shear stresses of the existing substrate, which, based on data collected to date, is very stable (Appendix B). These calculations therefore indicate that under the

conditions measured to date, protective cover materials would remain in place as a stable protective cover over the long term. Under normal conditions, surface water velocities in the fringe marshes are low because these areas are out of the active channel of Bayou d'Inde and are sheltered by berms and vegetation, limiting wind-driven currents. In addition, because the fringe marshes are shallow, tidal exchange volumes are low and corresponding tidal current velocities are minimal.

An assessment of the stability of the cover material under more extreme conditions should be evaluated in the engineering design phase to select the volume and type of cover materials that are suitable under a wide range of conditions. However, data collected as part of the supplemental sampling program (Appendix B) and as part of the post-Hurricane Rita evaluation (Anchor 2006a) do not provide any indication that significant or large-scale sediment scour would occur at the Site as a result of an extreme event like Hurricane Rita. Moreover, some small-scale movement of the material in the protective cover is expected over time; any such movement would not represent failure of the cover. For these reasons, an erosion-resistant layer, such as that discussed in Section 3.1.3 and 3.1.4 for the AOI 1 Removal/Capping and Removal/Backfilling alternatives (because surface water velocities in AOI 1 could, at times, cause resuspension and transport of bottom sediments), is unnecessary for the 6-Inch Cover alternative in AOI 3. The ARARs associated with the Sediment Cover remedial alternative are related to maintaining water quality while placing the sediment cover. None of the ARARs would pose an insurmountable challenge to implementing the Sediment Cover remedial alternative in AOI 3.

3.3.4 Screening of Remedial Alternatives for AOI 3

The screening of remedial alternatives for AOI 3 is summarized in Table 3-8. As explained in Section 3.3, removal was not developed as a remedial alternative for AOI 3 because the access needs of the equipment required to remove sediment and the removal activity itself would cause disruptions to viable habitat that are out of proportion to the risks associated with impacted sediment in this AOI. Further, sediment removal is not needed to achieve the approved remedial standard in AOI 3. The MNR alternative was not retained for the detailed evaluation in Section 4.3 because conditions in the fringe marshes, particularly the low sedimentation rates, do not

indicate that MNR would be effective as a stand-alone remedy for AOI 3. However, natural recovery processes will continue in the future and will contribute to the overall improvement in COC concentrations in surface sediments at the Site. The two 6-Inch Cover alternatives were retained for the detailed evaluation.

The remedial alternatives retained for detailed evaluation for AOI 3 are:

- No Further Action
- 27-Acre 6-Inch Cover
- 39-Acre 6-Inch Cover

3.4 AOI 4 Remedial Action Alternatives

AOI 4 is Lockport Marsh, a 470-acre area of mostly open water and some small vegetated islands located on both sides of Bayou d'Inde (Figure 1-5). The water depth in AOI 4 ranges from approximately 0 to 4 feet with tidal variation. The portion of AOI 4 on the northeastern side of Bayou d'Inde is crossed by several levees that serve as oil field roads and also contains several small elevated oil well platforms and oil-field support areas. Both abandoned and in-service utility pipes also cross AOI 4 northeast of Bayou d'Inde. The PPG Canal forms the northern boundary of a portion of AOI 4 (Figure 3-17).

Nearly all of the sediments in AOI 4 with the highest mean PEC-Q values are located within two areas bordered by oil field roads and the PPG Canal (Figure 2-1). A similar pattern, although somewhat less distinct, is observed for mercury concentrations (Figure 2-2) and also for dioxin/furan TEQs (Figure 2-4). Because they are generally above the high water line, the roads form a barrier to sediment movement in Lockport Marsh, which has contained much of the impacted sediment within the areas bounded by the roads. The two impacted sub-areas within the portion of AOI 4 bordered by the oil field roads are shown on Figure 3-17 as an 11-acre sub-area and a 112-acre sub-area. Both sub-areas are mostly surrounded by existing roads that have limited the movement of water and sediment. The larger sub-area is crossed by the 7-acre Interstate 210 bridge corridor.

Remedial alternatives were developed for AOI 4 with the intention of reducing the SWA mean PEC-Q value and the SWA dioxin/furan TEQ and mercury concentrations. Remedial alternatives using MNR, in situ capping, and removal were developed in addition to No

Further Action. The corrective action alternatives developed for AOI 4 are described in the following sections and summarized in Table 3-9.

3.4.1 No Further Action in AOI 4

The No Further Action alternative would involve taking no steps to mitigate impacted sediment and no monitoring of AOI 4. The SWA mean PEC-Q value in surficial (0 to 1-foot interval) sediment in all of AOI 4 is 0.30, which is in the low risk range used by EPA in the BERA, but mean PEC-Q values within the areas bounded by the oil field roads generally exceed 0.4 and some areas exceed 0.56. Mercury concentrations and dioxin/furan TEQ values in the areas bounded by the roads are also significantly higher than the values in the rest of AOI 4. To address the approved remedial standard, remedial alternatives were developed to reduce the SWA mean PEC-Q values, SWA mercury concentration, and SWA dioxin/furan TEQ values in AOI 4. Although the No Further Action alternative would fail to meet the approved remedial standard, it is retained through the screening process and considered in the detailed evaluation of remedial alternatives as a basis for comparison as required by LAC 33:VI.509.C.1.

3.4.2 Monitored Natural Recovery in AOI 4

MNR processes were evaluated in the CAS, and field data were gathered from three locations (BD01, BD02, and BD03) in AOI 4 (Figure 3-17) specifically to evaluate the potential for physical natural recovery processes to isolate the impacted sediment and eliminate or significantly reduce exposure pathways to ecological and human receptors. The MNR evaluations involved the following:

- Sedimentation rates were estimated from analysis of radioisotopes in the sediment column.
- The quality of recent and historically deposited sediment was assessed with whole-sediment chemical analyses.
- The stability of the sediment was assessed using sediment flume testing and surface water velocity measurements.

The evaluations of all of these data are presented in Appendix B. The estimated sedimentation rate for the area surrounding BD01 is between approximately 0.59 and 0.90 cm/year. This rate may overestimate natural sedimentation rates because the

settling of suspended solids associated with dredge material disposal in the 1960s likely increased sedimentation rates during that period. The estimated sedimentation rate for the area surrounding BD02 is between approximately 0.33 and 0.65 cm/year. The estimated sedimentation rate for the area surrounding BD03 is between approximately 0.02 to 0.27 cm/year.

With respect to sediment chemistry at BD01, BD02, and BD03, the concentrations of COCs were generally lower in the 0 to 2-cm samples than in the 0 to 11-cm intervals (see Appendix B). This observation suggests that clean sediments coming into the system are slowly covering or mixing with older, more impacted, sediments and reducing the concentrations of many constituents.

It also appears that sediments deposited in the Lockport Marsh are hydrodynamically stable. As discussed in Appendix B, and similar to the discussion in Section 3.3.2, field measurements of velocity showed that surface water velocities rarely produce shear stresses required to resuspend and/or scour surface sediments (see Appendix B).

In summary, the concentrations of many chemical constituents are apparently decreasing in the most recently deposited sediment in AOI 4 and bed stability analyses indicate that these sediments are likely stable over the long term following deposition. Although low sedimentation rates limit the effectiveness of MNR as a remedial technology for large-scale application in Lockport Marsh, these processes are occurring and provide an added factor of safety to more active remedial actions.

In addition to natural recovery by clean sediments coming into the system, biochemical processes may reduce PCB concentrations and sequester mercury in sediment. The effectiveness of these processes has not been demonstrated, particularly in shallow waters where dissolved oxygen would inhibit these largely anaerobic processes.

There are no ARARs associated with implementing the AOI 4 MNR remedial alternative.

3.4.3 Sediment Cover in AOI 4

The in situ capping alternative for AOI 4 involves placing a 6-Inch Cover over 123 acres of impacted sediment. Figure 3-17 shows the lateral extent of the cover. The extent of the cover was selected based on the areas of mercury, mean PEC-Q, and dioxin/furan TEQ impacts described in Section 3.4. As discussed in Section 3.3.3, the 6-Inch Cover involves discharging clean sediment to the target area to reduce surface concentrations of COCs.

The extent to which cover material mixes with native sediment would depend on several factors such as the cover placement technique, the water depth, and the geotechnical characteristics of the native sediment. For purposes of this evaluation, a 75 percent reduction in surface concentrations was assumed, consistent with the discussion of 6-Inch Cover placement in AOI 3.

The 6-Inch Cover alternative would involve placing a volume equal to a minimum of 0.5 foot of clean fine-grained material into the previously identified areas of AOI 4. In actual construction, application of excess cover material is assumed to be necessary for the contractor to achieve the minimum 0.5-foot cover thickness throughout the area. This excess material is referred to as overplacement. An overplacement allowance of 0.5 feet was assumed in developing the cost estimates for 6-Inch Cover alternatives in the CAS.

The 6-Inch Cover would greatly reduce surface concentrations of COCs in the AOI. The anticipated reductions in the SWA mean PEC-Q and dioxin/furan TEQ values and SWA mercury concentration for AOI 4 (including the consolidated material from AOI 2) and the performance of the alternative relative to the approved remedial standard are discussed in greater detail in Section 4.4. A discussion of the stability of the 6-Inch Cover is included in Section 3.3.3 and Appendix B.

Prior to placing the 6-Inch Cover, the elevation of the existing roads may be raised or sidecast earthen levees may be built to control the placement of sediment, aid in the settling of hydraulically placed sediment, and control the discharge of excess water. Recent construction in Lockport Marsh has demonstrated the feasibility of constructing

earthen sidecast levees in this area. The roads would be used to provide containment for installing an in situ cap and/or for raising water levels to facilitate the movement of equipment within the AOI. Construction in AOI 4 could be impeded by the shallow water depths, which prevent the use of normal water-based vessels (insufficient draft) and various pipeline crossings. The design of caps and new or improved containment structures would also need to consider and avoid impacts to existing structures (including wells, pipelines, and the Interstate 210 bridge) within Lockport Marsh. As discussed in Section 3.2.4, the design of the remedial alternative would need to consider methods for protecting existing structures, including current and abandoned oil wells and pipelines, and preventing releases of oil from such structures during construction.

The ARARs associated with the Sediment Cover remedial alternative are related to maintaining water quality while placing the sediment cover. None of the ARARs would pose an insurmountable challenge to implementing the Sediment Cover remedial alternative in AOI 4.

3.4.4 Removal in AOI 4

The Removal/Cover alternative would involve removing approximately 1.5 feet of sediment from the 123 acres designated on Figure 3-17. The depth of removal of 1.5 feet of sediment is based on the chemical profiles of COCs measured in core BD01 during the supplemental data collection activities (Appendix B). A 0.5-foot overdredge allowance is included in the cost estimate for this alternative. The total volume of sediment removed from AOI 4 would be approximately 400,000 cy. The cost estimate is based on the assumption that the dredged sediment would be dewatered and taken to a commercial landfill for disposal. Using two mechanical dredges on specialized equipment operating at 500 cy per day, the dredging operation would take approximately 1 year to complete.

The existing oil field roads would facilitate controlling water quality during implementation of the Removal/Cover remedial alternative. However, existing pipelines, concrete slabs, debris, and wells would interfere with sediment removal and could be damaged. Therefore, all obstacles would need to be surveyed prior to dredging. Active pipelines would need to be rerouted and other obstacles would need

to be removed or avoided during dredging. The design of the remedial alternative would need to consider methods for protecting existing structures, including oil wells and pipelines, and preventing releases of oil from abandoned facilities during construction. Construction plans for the I-210 bridge corridor would need to be reviewed by LDOTD.

The ARARs associated with the Removal remedial alternative are related to maintaining water quality while dredging sediment from AOI 4. None of the ARARs would pose an insurmountable challenge to implementing the Removal alternative in AOI 4.

3.4.5 Screening of Remedial Alternatives for AOI 4

The screening of remedial alternatives for AOI 4 is summarized in Table 3-10. The MNR and Removal alternatives were not retained for detailed evaluation in Section 4.4. The MNR alternative was not retained for the detailed evaluation because conditions in Lockport Marsh, particularly the low sedimentation rates, do not indicate that MNR would be effective as a stand-alone remedy for AOI 4. However, natural recovery processes will continue in the future and will contribute to the overall improvement in COC concentrations in surface sediments at the Site. The Removal alternative was not retained for detailed evaluation because removal of sediment in the 123-acre area would be only marginally more effective than the 6-Inch Cover alternatives in this area, while the cost of removal would be more than five times greater than the cost of the 6-Inch Cover alternatives. There are also significant risks associated with the abandoned oil field wells and pipelines that would be exacerbated in implementing a removal action as compared to placing the sediment cover. The 6-Inch Cover alternative would cause less of an environmental impact and would be stable (Section 3.3.3 and Appendix B). In addition, underground piping, surface structures, and wells would need to be removed or rerouted before the sediment was removed. This process would be expensive and difficult and would require the cooperation of the corporate entity operating the oil and gas extraction field.

Implementation of the 6-Inch Cover alternative would be more straightforward in AOI 4 than in AOI 3, because the water depth is greater, the target areas are already mostly enclosed by oil field roads, and there is relatively little vegetation to obstruct equipment

movement. As discussed in Section 3.3.3, an erosion-resistant layer is not necessary for the 6-Inch Cover remedial alternatives, because the mixed cover layer is stable (shear stresses are rarely exceeded), movement of the sediment in the mixed layer of cover material would not present a risk because the concentrations of COCs have been reduced to acceptable levels, and because the oil field roads limit surface water movement in AOI 4 and deflect currents that may be generated in exterior portions of Lockport Marsh.

The remedial alternatives retained for detailed evaluation for AOI 4 are:

- No Further Action
- 123-Acre 6-Inch Cover

3.5 Summary of Remedial Alternatives Retained for Detailed Evaluation

The following AOI-specific remedial alternatives were retained for detailed evaluation:

- AOI 1
  - No Further Action
  - MNR
  - Removal/Capping (18,500 cy)
  - Removal/Backfilling (47,000 cy)
  - In Situ Capping (Option 1) (17,000 square yards)
  - In Situ Capping (Option 2) (36,300 square yards)
- AOI 2
  - No Further Action
  - Removal (Option 1) (42,000 cy)
  - Removal (Option 2) (97,000 cy)
- AOI 3
  - No Further Action
  - 6-Inch Cover (27 acres)
  - 6-Inch Cover (39 acres)
- AOI 4
  - No Further Action
  - 6-Inch Cover (123 acres)

4 DETAILED EVALUATION OF ALTERNATIVES

Both Section IX.B of the Cooperative Agreement and LAC 33:VI.509.C.4 identify criteria for the detailed evaluation of remedial alternatives. The detailed evaluation of alternatives for each AOI that is included in this section uses the following criteria that incorporate both the Cooperative Agreement and LAC requirements:

1. Ability of the remedial alternatives to achieve the approved remedial standard
2. The long-term effectiveness and permanence of the remedial alternatives
3. Reduction of toxicity, mobility, or volume (TMV) of hazardous constituents through treatment
4. Short-term effectiveness
5. Implementability
6. Cost effectiveness
7. Compliance with all state and federal ARARs

The approved remedial standard for the Site involves evaluation of (1) reductions in the SWA of mean PEC-Q values, dioxin/furan TEQ values, total TEQ values, and concentrations of mercury and PCB Aroclors; (2) the overall distribution of these chemical constituents both pre- and post-remedy; and (3) predicted reductions in risk to specific receptors. Section 2 of this report discusses in detail the way in which reductions in SWA values and concentrations are related to reductions in incremental risks to ecological and human receptors. Tables 4-1 through 4-5 summarize the anticipated performance of the remedial alternatives relative to the approved remedial standard, as well as the costs associated with all of the remedial alternatives evaluated in detail. Specifically, Tables 4-1 through 4-4 summarize the percent reduction in SWA values of mean PEC-Q, mercury, Aroclor PCBs, and dioxin/furan TEQs in sediments and the corresponding reduction of risk to piscivorous birds and mammals resulting from these changes. Table 4-5 summarizes the percentage of the total area in each AOI where the mean PEC-Q currently exceeds 0.33 (the low/indeterminate risk threshold in the BERA), 0.56 (the indeterminate/high risk threshold), or 1.0, as well as the percentage of the total area in each AOI that is projected to exceed these values following each of the remedial alternatives.

The detailed cost estimates for each of the alternatives are provided in Appendix F. The detailed evaluation of remedial alternatives relative to all of the criteria described above is presented in Sections 4.1 through 4.4.

4.1 AOI 1 Alternatives Evaluation

The remedial alternatives evaluated in detail for AOI 1 are:

- No Further Action
- Monitored Natural Recovery
- Removal/Capping (18,500 cy removal over 11,000 square yards of sediment bed, placement of engineered granular cap)
- Removal/Backfill (47,000 cy removal over 28,000 square yards of sediment bed, replace with clean earthen fill)
- In Situ Capping, Option 1 (17,000 square yards of ABM)
- In Situ Capping, Option 2 (36,300 square yards of ABM)

4.1.1 Ability to Achieve the Remedial Standard Evaluation for AOI 1

The No Further Action alternative would not achieve the approved remedial standard. The current, or baseline, SWA mean PEC-Q value for surficial sediments is 0.47, which is in the indeterminate risk range, as defined in the BERA. Under the No Further Action alternative, no monitoring would be performed to assess whether surface concentrations of PCBs were reduced over time to lower the SWA mean PEC-Q value to an acceptable level.

The risk reduction that may be achieved by the MNR alternative cannot be assessed in detail because the deposition rate and the stability of new sediments have not been quantified. Over time, deposition of clean sediment would be expected to reduce surface concentrations and isolate impacted sediment from potential receptors. The fact that the SWA mean PEC-Q remains in the indeterminate risk range several decades after the releases likely occurred indicates that the MNR alternative would be less effective than the removal or in situ capping alternatives.

Both of the removal alternatives would substantially reduce average PCB concentrations, and by extension, mean PEC-Q values, in surficial sediments. The Removal/Capping alternative would reduce the SWA mean PEC-Q value by approximately 44 percent. The Removal/Backfilling alternative would reduce the SWA mean PEC-Q value by approximately 53 percent (i.e., an additional 9 percentage points). The Removal/Capping alternative would reduce the SWA total PCB concentration by

approximately 61 percent, and the Removal/ Backfilling alternative would reduce the SWA total PCB concentration by approximately 73 percent (i.e., an additional 12 percentage points). This comparison suggests that the additional risk reduction from the Removal/Backfilling alternative would be relatively small.

Both of the In Situ Capping alternatives would substantially reduce risk to potential receptors by containing impacted sediment. The in situ cap would provide a barrier between impacted sediment and potential receptors. For the purpose of estimating the SWA PCB concentration and mean PEC-Q values for the two alternatives, the lowest concentration or value observed in the AOI was assigned to the capped areas to calculate the post-remedial action SWA values. This is the same approach used for the two removal alternatives. The In Situ Capping alternatives would reduce the SWA mean PEC-Q value by approximately 44 percent (Option 1) or approximately 53 percent (Option 2). The SWA total PCB concentration would be reduced by approximately 61 percent (Option 1) or approximately 73 percent (Option 2). As with the Removal/Capping and Removal/Backfilling alternatives, this comparison suggests that the additional risk reduction from Option 2 would be relatively small, although the certainty of long-term effectiveness would be enhanced with Option 2 as discussed in Section 4.1.2.

Table 4-1 summarizes the existing and anticipated SWA mean PEC-Q, mercury, PCB, and TEQ values, as well as estimated reductions of risk to the key receptor groupings. Table 4-5 summarizes the degree to which the remedial alternatives reduce the percent area of AOI 1 with elevated mean PEC-Q values. Either removal alternative would reduce the SWA mean PEC-Q for surficial sediments to the low risk range (i.e., 0.26 and 0.22, respectively). Similarly, because essentially the same sediments would be addressed, the In Situ Capping alternatives would reduce the SWA mean PEC-Q to the low risk range (0.26 for Option 1 and 0.22 for Option 2). Figure 4-1 illustrates, relative to the risk thresholds established in the BERA, the change in mean PEC-Q value achieved by the remedial alternatives as compared to the current, or pre-remedy, value. The figure includes the risk thresholds established in the BERA. In addition, the removal or isolation of PCBs from surficial sediments would reduce or eliminate the ability of these sediments to act as potential sources of PCBs to downstream sediments and biota.

4.1.2 Long-Term Effectiveness Evaluation for AOI 1

The No Further Action alternative would not effectively achieve the approved remedial standard and so is not expected to be effective in the long term. Similarly, because of the relatively low sedimentation rate, the MNR alternative, standing alone, is not expected to have a high degree of long-term effectiveness, although natural recovery processes would help to reduce concentrations in the long term to some degree.

The Removal/Capping and Removal/Backfill alternatives would effectively achieve the approved remedial standard through the removal of significant volumes of impacted sediment and the placement of an engineered cap or clean backfill. The long-term effectiveness or reliability of the backfill or cap is related to the thickness of the cap and the stability of the capping material under the range of potential surface water flow conditions.

The engineered cap in the Removal/Capping alternative would include an armor layer that would be designed to resist erosion under reasonably expected erosive flow conditions. The design of the alternative would include surface water flow modeling to estimate peak velocities that would act on the cap and selection of a capping material grain size to resist the erosive forces associated with these flow conditions. In addition to the selection of erosion-resistant materials, the surface elevation of the cap would be designed to be similar to the current mudline elevation to maintain the current cross-sectional area of the channel.

The Removal/Backfill alternative would rely on the thickness of the cap and the stability of the finished elevation, rather than grain size, for long-term effectiveness. As with the Removal/Capping alternative, the surface elevation of the backfill would be approximately the same as the current mudline, which is presumably in a steady state balance between erosion and deposition. Even extremely erosive events that might remove inches of material from the bed would not significantly affect the 5-foot-thick layer of clean backfill. Following this hypothetical erosive event, the channel bed would be below the steady state condition and so sediment deposition would be expected until the stable mudline elevation was restored.

In Situ Capping with fabric formed concrete mats provides a long-term durable barrier between contaminated sediment and the water column. The cap is primarily formed by a layer of concrete. ABM is anticipated to be the preferred cap for this application because of its flexibility to conform to changes in the cross-section of the channel as the underlying sediment consolidates. The concrete blocks in 4-inch-thick ABM are approximately 10 by 20 inches and weigh 75 pounds each, considerably more massive than the coarse erosion-protection material that would be needed for the granular engineered cap. The blocks are joined by continuous layers of geotextile and reinforced by synthetic cables embedded in the blocks. Sediment beneath the cap is contained by the blocks and the geotextile. These structural elements of the cap would prevent resuspension of sediment and direct contact by benthic organisms in the long term. Fabric formed concrete mats have been used for years for erosion protection and capping sediment. One installation for erosion protection that is near the Site, in the PPG Canal, has been in place and performed as designed for 15 years. The size and weight of the individual blocks would resist disruption of the cap even under high surface water velocity, and the reinforcing cables further stabilize the ABM by attaching each block to the adjacent blocks.

The larger in situ cap (Option 2) would provide greater certainty of effectiveness in the long term. While the reduction of SWA PCB concentrations for the two in situ cap options is comparable, Option 1 would leave the upstream segment uncapped and potentially subject to erosion of the surface sediment, which would transport PCB contamination downstream and potentially expose sediment with higher PCB concentrations. Under Option 2, all of the sediment with known elevated concentrations of PCBs would be capped and effectively contained and isolated for the long term.

4.1.3 Reduction of TMV Evaluation for AOI 1

The remedial alternatives evaluated for AOI 1 would achieve the approved remedial standard and protect human health and the environment by removing and/or containing the impacted sediment and blocking the exposure pathway between the hazardous constituents and potential receptors. Treatment technologies were considered for dredged sediment, as discussed in Section 3, but were screened from further consideration for the reasons described in that section.

None of the remedial alternatives evaluated for AOI 1 would reduce the TMV of the hazardous constituents through treatment; rather, physical barriers would be used to limit sediment mobility and isolate the sediment from potential receptors.

4.1.4 Short-Term Effectiveness Evaluation for AOI 1

The short-term effectiveness evaluation considers potential hazards associated with implementation of the remedial alternative, as well as the time required for the remedial alternatives to achieve the approved remedial standard.

Implementation of the No Further Action alternative would not pose any hazards to human health (the community at large or remediation workers) or the environment, although existing risks associated with PCBs in sediment would remain unabated. The time to achieve effectiveness cannot be evaluated for No Further Action, since the approved remedial standard would not be achieved in any recognized time frame. The MNR alternative is similar in that implementation of this alternative would pose minimal risks to workers collecting samples and would not pose any hazards to the community or the environment. As with No Further Action, the time to achieve effectiveness cannot be evaluated for MNR, since this remedial alternative is not expected to achieve the approved remedial standard.

The removal alternatives would involve resuspending impacted sediment. While controls can be implemented to reduce the transport of resuspended sediment, there is no practical way to eliminate the release of contaminated sediment from the work area since there is flow in the bayou and the removal area spans the entire width of the channel. The Removal/Backfilling alternative also introduces a greater risk of destabilizing the banks of this portion of Bayou d'Inde because of the depth of the required dredge cut. The remedial alternatives would be effective as soon as the removal and backfill or cap placement operations were completed. The estimated time to implement the alternatives is 5 months for Removal/Capping and 12 months for Removal/Backfilling.

Implementation of the In Situ Capping alternatives would pose considerably less risk to human health or the environment from resuspension of impacted sediment than the removal alternatives. Placing the ABM cap should cause minimal resuspension of sediment. The installation of the ABM includes placing a layer of geotextile directly on the impacted sediment. The placement of this material involves drawing the fabric across the channel in the water column and then sinking it to the sediment surface. Sinking the geotextile onto the sediment imparts very little energy that would cause sediment to resuspend. Further, although water will pass through the geotextile, sediment is retained below the material. After the first layer of geotextile ("bedding" geotextile) is in place, effectively preventing resuspension of sediment from the work area, the fabric form—a double layer of a different type of geotextile—is placed using essentially the same technique as that described for placing the bedding geotextile. The fabric form is also permeable to water but traps sediment particles. The cement grout is pumped into the fabric form only after both the bedding geotextile and the fabric form are completely settled on the sediment. The In Situ Capping alternatives would achieve full effectiveness immediately upon construction. The estimated time to implement the alternatives is 2 months for Option 1 and 3 months for Option 2. The short-term effectiveness of either In Situ Capping option is enhanced compared to the Removal/Capping or Removal/Backfilling remedial alternatives because the time to achieve effectiveness is shorter, there is considerably less potential to resuspend and transport contaminated sediment, and there is less potential for exposing construction workers to contaminated sediment.

4.1.5 *Implementability Evaluation for AOI 1*

The technologies, equipment, and personnel required to implement any of the remedial alternatives are available. Particular implementability issues associated with the remedial alternatives were assessed.

The monitoring and reporting for the MNR alternative would present no implementability issues and sufficient samples could be collected to account for heterogeneity of the surface sediment. The ability of natural processes to reduce the SWA mean PEC-Q value and SWA total PCB concentrations to acceptable levels within

a reasonable timeframe in the absence of other remedial action has not been demonstrated.

The Removal/Capping alternative would involve dredging approximately 18,500 cy of sediment from approximately 950 feet of the bayou and placing approximately 14,300 cy of capping material. The techniques for both of these operations are well demonstrated and contractors qualified to perform these operations at remedial action sites are readily available. The primary implementability issues will be equipment access to this portion of Bayou d'Inde, controlling water quality in Bayou d'Inde during construction, and meeting design criteria for sediment removal and cap placement.

The operations required for the Removal/Backfilling alternative are similar to those required for the Removal/Capping alternative, except that the quantities of material are approximately two to three times greater. Due to the greater depth of sediment removal, the banks would need to be stabilized by driving sheet piling into the banks outside of the channel. The sheet pile driving would require the removal of trees and other vegetation, as well as the removal of stumps and larger roots from the channel banks. Construction activities above the mean high water level would require access agreements from the owners of the affected properties.

The sediment removed from AOI 1 under either removal alternative would be dewatered at an upland staging area constructed adjacent to the AOI and transported by truck or rail to a commercial landfill for disposal. An upland facility with a dock for unloading sediment from barges, for staging sediment for dewatering, and for loading dewatered sediment into trucks would need to be sited and developed for either removal alternative. An upland staging area would also be required for the In Situ Capping alternatives, although the facility would be smaller and siting may be more flexible.

The In Situ Capping alternative (Option 1) would involve placing approximately 17,000 square yards of bedding geotextile and in situ formed concrete mat. Option 2 would involve placing approximately 36,300 square yards of bedding geotextile and in situ formed concrete mat. This technology has been demonstrated at sites with similar size

channels and water velocities. Site preparation would involve removing stumps and other obstructions or reducing the degree to which they protrude from the sediment. An anchor trench would also be required along the top of each bank for the entire length of the cap. Trees and other vegetation would need to be removed to prepare the anchor trench. The techniques for these operations are well demonstrated and contractors qualified to perform them at remedial action sites are readily available. The primary implementability issue would be equipment access to this portion of Bayou d'Inde.

The In Situ Capping alternative offers several implementability advantages.

- Water quality should be easier to control than it would be during dredging or the placement of granular cap materials because the lightweight geotextiles being placed impart little energy that could resuspend native sediment.
- The placement of the concrete capping material is more easily controlled and more uniform than the placement of sand and gravel, as it is contained within the geotextile form.
- The concrete mat offers the advantage of helping to stabilize the banks of the channel.

All of the removal alternatives and In Situ Capping alternatives would require establishing a staging area adjacent to AOI 1. A potential location for the staging area is located approximately 1,700 feet upstream of sample location BD21 (Figure 3-1). The staging area would be used to perform the following operations (not all of which apply to all of the alternatives):

- Bring equipment to the work site and launch equipment into the water
- Offload, stockpile, and dewater sediment removed from AOI 1
- Load sediment into trucks
- Unload and store capping materials
- Load capping materials onto barges for placement in AOI 1

The use of upland areas adjacent to AOI 1 for staging—as well as the removal of sediment, removal of vegetation, placement of fill, and excavation of the anchor trench in upland areas—would require the approval of the property owners. More upland area

would be required for the Removal/Backfill or In Situ Capping alternatives than for the Removal/Capping alternative.

For all of the alternatives, the hydraulic capacity of the channel in AOI 1 was considered to be an important factor. Bayou d'Inde provides significant drainage capacity for the City of Sulphur and surrounding lands. To prevent impacts on drainage, any of the remedial alternatives considered would be designed to result in insignificant loss of hydraulic capacity in Bayou d'Inde. For the two removal alternatives, impacted sediment would be removed from the channel and replaced with approximately the same amount of capping material or clean sediment. The In Situ Capping alternative would involve the placement of a thin layer (approximately 4 inches average thickness) of concrete and geotextile that would, even without any consolidation of underlying sediment, result in a minimal decrease of the cross-sectional area of the channel. However, recently deposited surficial sediments tend to be unconsolidated relative to sediments located at greater depth in the sediment bed, and some consolidation would be expected under the type of uniform loading conditions that would result from the placement of the ABM cap. While the amount of consolidation of the sediments under the loading of the ABM cap has not been quantified for purposes of the CAS, some consolidation would probably take place and would tend to mitigate any loss of cross-sectional area.

The No Further Action and MNR alternatives have no implementability issues. The Removal/Capping alternative and the In Situ Capping alternatives have certain equipment access issues discussed above and would require coordination with the U.S. Army Corps of Engineers (USACE) and LDEQ to demonstrate that the substantive requirements of regulatory programs (see Section 4.1.4) were addressed. The In Situ Capping alternative also has administrative implementability issues, including obtaining property access for anchor trench excavation and installation and developing and implementing institutional controls to protect the integrity of the cap. The Removal/Capping alternative would also include institutional controls to protect the cap. The Removal/Backfilling alternative has similar regulatory coordination issues, somewhat greater technical access issues related to the installation of upland bank stabilization controls, and significantly greater technical implementability issues (related

to bank stabilization) and administrative implementability issues (property access for upland bank stabilization work). None of the implementability issues is insurmountable, assuming that affected property owners agree to allow access for bank stabilization required for the Removal/Backfilling alternative or anchor trench installation required for In Situ Capping and for the other upland facilities required for any of the alternatives.

4.1.6 Cost Evaluation for AOI 1

The estimated present worth cost of the MNR alternative is approximately $500,000. This cost estimate includes the development of a Sampling and Analysis Plan, collection of samples, and reporting results. The cost estimate is based on several assumptions, including that a baseline round of samples would be collected, followed by annual sampling for five years and less frequent sampling after the fifth year. The scope of each sampling event was assumed to include collecting 20 sediment samples and analyzing the samples for PCB congeners.

The estimated cost of the Removal/Capping alternative is $9.8 million. The removal portion of this cost estimate assumes that approximately 18,500 cy of sediment would be removed, dewatered, and transported to a commercial landfill for disposal. The capping estimate assumes that approximately 12,300 cy of sand and 6,200 cy of gravel would be required.

The estimated cost of the Removal/Backfilling alternative is $24.4 million. The removal portion of this cost estimate assumes that approximately 47,000 cy of sediment would be removed, dewatered, and transported to a commercial landfill for disposal. The backfill estimate assumes that approximately 47,000 cy of fill would be required. The cost estimate also assumes that approximately 40,000 square feet of sheet pile would be required for shoreline stabilization.

The estimated costs of the In Situ Capping alternatives are $3.4 million for Option 1 and $6.1 million for Option 2. Option 1 would involve placing approximately 17,000 square yards of ABM cap in the downstream segment of AOI 1, where most of the PCB-impacted sediment has been found. Option 2 would involve placing approximately

36,300 square yards of ABM cap over the upstream and downstream segments. Under both options, the entire width of the channel would be capped.

The cost estimates are summarized in Table 4-1. Greater detail is provided in Appendix F.

4.1.7 ARARs Evaluation for AOI 1

Appendix H contains a comprehensive list of the ARARs considered in this detailed evaluation of remedial alternatives. The evaluation of ARAR considerations and applicable health and safety requirements for the AOI 1 remedial alternatives are discussed in the remainder of this section.

The sediment removal and capping or filling operations would need to follow the substantive standards required under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Impacts to water quality would be monitored to meet requirements identified by the USACE. As the volume of capping material or fill that would be added to the waterway is the same or less than the volume of sediment that would be removed under the Removal/Capping and Removal/Backfilling alternatives, the remedial action would be consistent with Executive Order 11988 on construction within a floodplain. The remedial design for the In Situ Capping alternatives would need to include a demonstration that the addition of the ABM would not increase the risk of flooding. Any water discharges from dewatering or treatment operations would need to meet Water Quality Standards (WQS) under the Louisiana Pollutant Discharge Elimination System (LPDES).

No information is available suggesting that the sediment contains listed hazardous waste, and based on the chemical data already collected, the sediment will not exhibit any hazardous waste characteristics. Therefore, off-site disposal of the sediment would not trigger Land Disposal Restrictions under the Resource Conservation and Recovery Act (RCRA). If the sediment is trucked to an off-site disposal facility, it would need to be dewatered, possibly by amendment with lime or Portland cement additives, before it leaves the staging area. The staging, dewatering, transportation, and disposal

operations would adhere to applicable requirements for transportation and disposal of non-hazardous solid waste.

Previous investigations (McLaren/Hart-ChemRisk 1998) concluded that there are no federally listed threatened or endangered species within the Site. There are, however, four species that may use the Site that are identified as locally rare (American White Pelican and Roseate Spoonbill) or imperiled (Caspian Tern and Osprey) by the Louisiana Department of Wildlife and Fisheries. The design and construction of remedial actions will need to consider the presence of these species to avoid detrimental impacts and will need to comply with other applicable natural resource protection laws and regulations.

Cultural resources have not been identified at the Site. The design and construction will need to preserve archaeological data, if any is present at the site. The design will include consultation with state and local agencies regarding the potential for encountering and the steps required for preserving archeological or historical information.

Implementation of remedial actions will involve potential contact with hazardous substances. Removal activities involve significantly greater potential for exposure than capping or monitoring activities. Design specifications for construction will require that contractors prepare a Health and Safety Plan (HASP) in accordance with applicable Hazardous Waste Operations (HAZWOPER) regulations and operate consistently with the plans. Work plans for monitoring activities would also include HASPs in accordance with applicable HAZWOPER regulations

4.2 AOI 2 Alternatives Evaluation

4.2.1 Ability to Achieve the Remedial Standard Evaluation for AOI 2

The current SWA mean PEC-Q value for AOI 2 (0.30) is in the low risk range as defined in the BERA. As noted in Section 3.2, most of the mean PEC-Q values in AOI 2 are in the range of 0.20 to 0.39. Table 4-2 summarizes the existing and anticipated SWA mean PEC-Q, mercury, PCB, and TEQ values, as well as estimated reductions of risk to the key receptor groupings.

The SWA total TEQ value in sediments in the lower portion of AOI 2, below the PPG Canal, is elevated. Total TEQ concentrations in surface sediment in the lower 5,600 feet of AOI 2 are presented in Figure 3-11. Generally, the highest TEQ concentrations have been found in the middle of the lower AOI 2 channel in the top 2 feet (71 cm) of sediment. Relative to the rest of AOI 2, mercury and PCB concentrations are higher as well in the lower portion below the PPG Canal.

The No Further Action alternative would leave sediment with elevated TEQ concentrations in place. Although mean PEC-Q levels within AOI 2 are low enough to support selection of the No Further Action alternative, this alternative would not directly address sediment with dioxin/furan TEQ concentrations that may pose unacceptable risks to piscivorous wildlife and human health, and would not include monitoring to determine whether the remedial actions in other AOIs (and the PPG Canal) were resulting in reductions in fish and shellfish tissue concentrations in achieving the desired level of risk reduction.

The Removal alternatives would involve dredging affected sediment from AOI 2 primarily to lower the SWA total TEQ value and secondarily to lower the SWA mercury and PCB values. Two options for sediment removal have been developed.

Option 1 would involve removing the sediment with the most elevated total TEQ concentrations. Option 1 would reduce the SWA TEQ concentration in the lower portion of AOI 2 by 75 percent, from approximately 752 nanograms per kilogram (ng/kg) to 188 ng/kg. In addition, the SWA mercury concentration in the lower portion of AOI 2 would be reduced by 60 percent, from approximately 1.82 mg/kg to approximately 0.71 mg/kg and the SWA PCB concentration would be reduced by 50 percent, from approximately 0.32 mg/kg to approximately 0.16 mg/kg. A total of 42,000 cy of sediment would be removed from AOI 2 under Option 1. Figures 3-10 and 3-12 illustrate the extent of sediment removal for Option 1.

The dredging limits for Option 2 were selected to restore lower Bayou d'Inde channel to the dimensions last dredged in 1967, to the degree that these dimensions can be ascertained from the as-built survey notes. As with Option 1, deeper dredging is

proposed as part of this option in the vicinity of sampling location BD34 because of the deeper impacts found at this location. The channel width also would be increased near the mouth of Bayou d'Inde. The extent of sediment removal is illustrated in Figures 3-13 and 3-14. A total of 97,000 cy of sediment would be removed under Option 2. Option 2 would reduce the SWA TEQ in the lower portion of AOI 2 by 78 percent, from approximately 752 ng/kg to approximately 169 ng/kg. Based on the available data, Option 2 would reduce the SWA mercury concentration in the lower portion of AOI 2 the same amount as Option 1, and would reduce the SWA PCB concentration by 60 percent, from approximately 0.32 mg/kg to approximately 0.13 mg/kg. The SWA concentrations resulting from Option 2 are not significantly lower than for Option 1. However, given the relatively low density of TEQ analyses in lower AOI 2, Option 2 would provide somewhat greater certainty that the anticipated TEQ reductions in local fish and shellfish tissue would occur over time as a result of the response action.

4.2.2 Long-Term Effectiveness Evaluation for AOI 2

The No Further Action alternative would not directly address sediment with dioxin/furan TEQ concentrations that may pose unacceptable risks to piscivorous wildlife and human health, and would not include monitoring to determine whether the remedial actions in other AOIs (and the PPG Canal) were resulting in the desired reductions in fish and shellfish tissue concentrations in AOI 2 over the long term.

Both of the removal alternatives would achieve the approved remedial standard through the removal of significant volumes of impacted sediment. The long-term effectiveness or reliability of the remedy would depend on the success of the dredging in removing most of the sediment with the highest TEQ concentrations. TEQ concentrations decrease with depth at all of the sampling locations, generally to very low levels within 2 feet of the current mudline (Appendix E), allowing a dredge to undercut and remove most of the impacted sediments. Option 1 would provide long-term effectiveness by removing the most highly contaminated sediments and using biomonitoring to evaluate the extent to which that removal, in conjunction with the response actions in the other AOIs (and in the PPG Canal), resulted in the anticipated reduction in fish and shellfish tissue concentrations over time. Option 2 would provide long-term effectiveness by removing more impacted sediment and thereby increasing

the likelihood that TEQ and other constituent concentrations contributing to risk have been removed.

The long-term effectiveness of consolidating and containing the dredged sediment in AOI 4 is discussed in Section 4.4.2. Off-site containment of the dredged sediment would provide long-term effectiveness through traditional engineered containment technologies and long-term monitoring.

4.2.3 Reduction of TMV Evaluation for AOI 2

The remedial alternatives evaluated for AOI 2 would achieve the approved remedial standard and protect human health and the environment by removing impacted sediment. Treatment technologies were considered for dredged sediment, as discussed in Section 3, but were screened from further consideration for the reasons described in that Section.

None of the remedial alternatives evaluated for AOI 2 would reduce the TMV of the hazardous constituents through treatment; rather, dredging would be used to remove the sediment from the AOI and containment methods would be used to limit mobility and isolate the dredged sediment from potential receptors.

4.2.4 Short-Term Effectiveness Evaluation for AOI 2

The short-term effectiveness evaluation considers potential hazards associated with implementation of the remedial alternative, as well as the time required for the remedial alternatives to achieve the approved remedial standard.

Implementation of the No Further Action alternative would not pose any hazards to human health (the community at large or remediation workers) or the environment, although existing risks associated with PCBs in sediment would remain unabated. The time to achieve effectiveness cannot be evaluated for No Further Action, since the approved remedial standard would not be achieved in any recognized time frame.

The removal alternatives would involve some resuspension of impacted sediment and an increased risk of short-term exposure of biota. Best management practices for

dredging and turbidity controls would be evaluated in design to minimize the transport of resuspended sediment.

Consolidation of dredged sediment in AOI 4 would involve less materials handling and fewer risks to workers and the public than off-site disposal, which would require loading and offloading of barges and trucks and an estimated 5,000 to 11,000 truck trips along public roads to and from a disposal facility (with their attendant risk of injury, death, or release of contaminated material due to traffic accidents).

The estimated time to implement the alternatives is 5 months for Option 1 and 8 months for Option 2, assuming consolidation in AOI 4, rather than off-site disposal, for managing the sediment dredged from AOI 2. If off-site disposal were required, either removal option would take longer, due to the need to locate or permit and construct an appropriate offloading facility, barge dredged sediment to the facility, offload and dewater the sediment, and load the sediment onto trucks for transportation to a landfill. The additional amount of time required for the off-site option will vary depending on the selection of offloading and disposal facilities. At a minimum, if a suitable existing offloading facility is identified that can be used for the project and if an existing commercial landfill is used, the slower mechanical dredging process would add approximately 1 month to the implementation time for Option 1 and 3 months for Option 2. The schedule extensions would be somewhat greater (at least 1 to 2 months) if a new offloading facility must be developed and probably much greater (perhaps more than a year) if a new landfill must be sited, permitted, and developed.

4.2.5 *Implementability Evaluation for AOI 2*

There are no implementability issues associated with the No Further Action remedial alternative. The technologies, equipment, and personnel required to perform the Removal alternatives are available. Controlling turbidity would be accomplished primarily through the selection of the dredging technology and secondarily through the implementation of best management practices for the selected dredging technology. The nature of the COCs would help to minimize potential impacts to water quality because:

- The sediment in AOI 2 is not severely impacted
- Dioxins and furans and PCBs adsorb strongly to sediment

Surface water flow modeling may be performed during remedial design to assess the transport potential of sediment resuspended by dredging operations or barge traffic during the implementation of the remedy. Such modeling, if necessary, would consider a variety of flow conditions, all of which would consider flow in Bayou d'Inde without the contribution of the PPG Canal since the current PPG Canal Reroute project should have redirected that flow to the Calcasieu River Ship Channel by late 2008 or early 2009.

Dredging operations would need to be timed to allow for barge traffic in Bayou d'Inde. This is a normal consideration for dredging in an active shipping channel. Given that the Bayou d'Inde channel is currently relatively shallow and generally narrow, the dredge operator would need to be prepared to shut down operations and move out of the channel when commercial traffic needs to pass. Dredging operations would need to be coordinated with other traffic and the dredge operator would need to maintain radio contact with other vessels.

Options to be considered for management of the sediment removed from the channel would be consolidation within AOI 4 or dewatering and transportation to either a commercial landfill or a newly permitted and constructed landfill for disposal. Material removed from the channel that is consolidated into AOI 4 would be placed in a portion of the 123-acre area that is under consideration for placement of a 6-inch clean sediment cover as a remedial alternative in AOI 4 (Figure 3-17). The technology and equipment to perform this operation are available. Sediment from AOI 2 may be dredged hydraulically and pumped to the consolidation area in AOI 4. Energy dissipating devices would be used to minimize the resuspension of native sediment in AOI 4 and facilitate the settling of the AOI 2 sediment. Levees would be constructed to hold the sediment and water from the dredging operation until the sediment has settled into the designated area within AOI 4. Smaller cells may be built within the disposal area in AOI 4 to facilitate settling and control of water.

If sediment were transported to an off-site landfill for disposal, a location would be required for offloading, dewatering, and transferring the sediment to trucks. Such a location with adequate access and capacity has not yet been identified, and consent from

the property owner (as well as the geotechnical conditions and time required to construct a staging and dewatering area) would be required if a commercial offloading facility were not used. Siting and developing the offloading facility for the off-site disposal option would add complexity and increase the time required to implement the remedial action; siting, permitting, and developing a project-specific landfill would further increase the complexity and time required. The production rate for this alternative would likely be limited by the rate at which the sediment could be hydraulically pumped to and consolidated in AOI 4 or could be unloaded from barges to an upland staging area for dewatering and off-site disposal, rather than by the capacity of the dredging equipment. As discussed for sediment removal in AOI 1, the Sediment Removal alternative would require coordination with the USACE and LDEQ to demonstrate that the substantive requirements of regulatory programs (see Section 4.1.7) were addressed.

4.2.6 Cost Evaluation for AOI 2

The estimated costs of the Removal alternatives are approximately $3 million for Option 1 and $5.4 million for Option 2, assuming that sediment removed from AOI 2 would be consolidated within AOI 4 (which is within the same general area of contamination). The cost estimates for the Removal alternative assume that approximately 42,000 cy of sediment would be removed for Option 1 and approximately 97,000 cy of sediment would be removed for Option 2. With either option, the dredged sediments would be placed in a portion of AOI 4 that is included within the 123-Acre 6-Inch cover (Figure 3-17), and the assumed approach is that the dredged AOI 2 sediment, as well as the impacted sediment in AOI 4, would be covered with the clean sediment cover. The cost estimates for the AOI 2 Removal alternatives also assume that the 6-Inch Cover remedial alternative would be selected for AOI 4. If the No Further Action alternative is selected for AOI 4, the additional costs to place a clean sediment cover over the material dredged from AOI 2 and placed in AOI 4 would be approximately $1.2 million for Option 1 (total cost $4.3 million) or $1.3 million for Option 2 (total cost $7.1 million), assuming a local source of clean cover material is available.

If off-site disposal were selected for sediment dredged from AOI 2, the estimated cost for Option 1 would increase to approximately $12.7 million for disposal in a commercial

landfill or $11.7 million for disposal in a newly developed dedicated off-site landfill. For Option 2, the cost estimates for the remedial alternative with off-site disposal would increase to approximately $27.7 million for disposal in a commercial landfill or $23.3 million for disposal in a newly developed dedicated off-site landfill.

The costs are summarized in Table 4-2. Greater detail is provided in Appendix F.

4.2.7 ARARs Evaluation for AOI 2

These are the same as those discussed in Section 4.1.7 for sediment removal in AOI 1.

4.3 AOI 3 Alternatives Evaluation

4.3.1 Ability to Achieve the Remedial Standard Evaluation for AOI 3

The current SWA mean PEC-Q value for surficial sediments in AOI 3 is 0.49, which is in the upper half of the indeterminate risk range as defined in the BERA. The elevated mean PEC-Q values are driven primarily by elevated PCB Aroclor concentrations; the SWA PCB Aroclor concentration in AOI 3 is approximately 0.263 mg/kg. The SWA mercury concentration is 1.51 mg/kg (Table 4-3). The No Further Action alternative would fail to address the approved remedial standard. The two 6-Inch Cover alternatives would reduce the SWA mean PEC-Q for surficial sediments to the lower portion of the indeterminate risk range, and also significantly reduce the SWA mercury and PCB Aroclor concentrations. Table 4-3 summarizes the existing and anticipated SWA mean PEC-Q, mercury, PCB, and TEQ values, as well as estimated reductions of risk to the key receptor groupings. Figure 4-1 illustrates, relative to the risk thresholds established in the BERA, the change in mean PEC-Q value achieved by the remedial alternatives as compared to the current, or pre-remedy, value. In addition, these alternatives would also significantly decrease the percent area of the AOI with elevated mean PEC-Q values (Table 4-5). Both 6-Inch Cover alternatives would satisfy the approved remedial standard. Achieving additional reductions in SWA concentrations would require a disproportionate amount of additional cover and would result in a disproportionate amount of habitat disruption due to increasingly difficult access issues in more remote areas of these fringe marshes.

4.3.2 Long-Term Effectiveness Evaluation for AOI 3

The No Further Action alternative would not effectively achieve the approved remedial standard within a known time frame and so is not expected to be effective in the long term.

Both of the 6-Inch Cover alternatives would achieve the approved remedial standard by substantially reducing the mean PEC-Q value and the concentrations of PCBs and mercury in sediment in the biotic zone. The placement of the 6-Inch Cover is expected to reduce concentrations of COCs to a depth of approximately 6 to 18 inches below the new mudline, assuming a minimum 6-inch cover and a 6-inch overplacement allowance. As the fringe marshes are expected to be in steady state or mildly depositional, the surface sediment (the new mudline) should be stable shortly after placement of the cover. If high flow conditions were ever to cause erosion in the fringe marshes, the depth of sediment disturbance—if any occurs—should be considerably less than the thickness of the mixed cover layer with reduced COC concentrations. Existing data indicate that critical shear stresses are exceeded in the fringe marshes only 0.02 percent of the time.

4.3.3 Reduction of TMV Evaluation for AOI 3

The 6-Inch Cover alternatives evaluated for AOI 3 would achieve the approved remedial standard and protect human health and the environment by greatly reducing concentrations of COCs in sediment in the top 6 to 18 inches below the mudline. Treatment technologies were considered for dredged sediment, as discussed in Section 3, but were screened from further consideration for the reasons described in that section. None of the remedial alternatives evaluated for AOI 3 would reduce the TMV of the hazardous constituents through treatment; rather, the clean sediment or sand cover would be used to reduce the potential exposure of biota to concentrations of COCs in the biotic zone.

4.3.4 Short-Term Effectiveness Evaluation for AOI 3

The short-term effectiveness evaluation considers potential hazards associated with implementation of the remedial alternative as well as the time required for the remedial alternatives to achieve the approved remedial standard.

Implementation of the No Further Action alternative would not pose any hazards to human health (the community at large or remediation workers) or the environment, although existing ecological risks associated with PCBs and mercury in sediment would remain unabated. The time to achieve effectiveness cannot be evaluated for No Further Action, since the approved remedial standard would not be achieved in any recognized time frame.

The 6-Inch Cover alternatives may involve some resuspension of impacted sediment, although the resuspended sediment should be readily contained since the impacted areas are generally isolated from surface water flow. The placement of the clean sediment cover would temporarily disrupt existing benthic habitat. The estimated time to implement the alternatives is 4 months for the 27-acre alternative and 5 months for the 39-acre alternative.

4.3.5 *Implementability Evaluation for AOI 3*

The equipment (which could include marsh excavators, hydraulic dredges, and ancillary equipment, such as spray nozzles or energy dissipating devices) and personnel required to place a 6-Inch Cover in AOI 3 fringe marshes are available. Working in the fringe marshes would be complicated by the shallow water depth, limited access (there are few openings to the Bayou d'Inde channel to enter the fringe marshes from the water and access from the land may require building roads through private property), and the presence of obstacles such as stumps, roots, and logs. Moving equipment around in the AOI 3 fringe marshes would be difficult for these reasons, and specialized equipment for working on mud and in shallow water would be required. This equipment is generally available on the Gulf Coast.

AOI 3 fringe marshes may be located within the property boundaries of private property owners, although the inundated portions may be subject to public access rights. Access agreements would be required from property owners in some locations where land-based staging and other activities are required before implementing the remedial action. The area affected by the remedial alternatives should be limited to the degree possible to limit the destruction of habitat associated with the removal of vegetation (required for

equipment access and placement of cover material) and to reduce the need for access to private property. As discussed for capping in AOI 1, implementing the 6-Inch Cover alternatives would require coordination with the USACE and LDEQ to demonstrate that the substantive requirements of regulatory programs (see Section 4.1.4) were addressed. The Group will work with LDEQ in assessing the need for access agreements based on the jurisdictional rights of the State over areas defined as navigable.

4.3.6 Cost Evaluation for AOI 3

The costs for the two 6-Inch Cover alternatives are similar (Table 4-3). The estimated cost for the 27-acre cover is approximately $3.1 million, and the cost for the 39-acre cover is approximately $4.0 million. For both alternatives, the source of cover material is assumed to be the Calcasieu River Ship Channel. Costs could be higher if clean sand had to be purchased from a local borrow source and transported to the Site. The volume of material required is assumed to be approximately 44,000 cy for the 27-acre alternative and 63,000 cy for the 39-acre alternative.

4.3.7 ARARs Evaluation for AOI 3

The ARARs associated with the 6-Inch Cover alternatives are the same as those discussed in Section 4.1.7 for In Situ Capping in AOI 1.

4.4 AOI 4 Alternatives Evaluation

4.4.1 Ability to Achieve the Remedial Standard Evaluation for AOI 4

The current SWA mean PEC-Q value for AOI 4 (0.30) is in the low risk range as defined in the BERA. However, there are relatively large contiguous areas within AOI 4 where mean PEC-Q values are in the upper end of the indeterminate risk range and lower end of the high risk range. The SWA dioxin/furan TEQ is 158 ng/kg (mammalian TEF) and elevated TEQ values in tissue samples from AOI 4 may be associated with exposure to sediment in AOI 4, although some species may be exposed to contaminants in other portions of their foraging range. The SWA mercury concentration in AOI 4 is 3.05 mg/kg (Table 4-4). Sediment areas with elevated mean PEC-Q and TEQ values and elevated mercury concentrations are co-located and clustered in the northeast portion of AOI 4 within a network of oil field access roads. There are also elevated values in a smaller semi-enclosed area south of and near the mouth of the Lower PPG Canal.

Remedial alternatives were evaluated to lower the SWA TEQ value and SWA mercury concentration in AOI 4 and to address the relatively large contiguous areas of elevated mean PEC-Q values. Table 4-4 summarizes the existing and anticipated SWA mean PEC-Q, mercury, PCB, and TEQ values, as well as estimated reductions of risk to the key receptor groupings. Figure 4-1 illustrates the change in mean PEC-Q value achieved by the remedial alternatives as compared to the current, or pre-remedy, value and relative to the risk thresholds established in the BERA.

The No Further Action alternative would fail to address the approved remedial standard because of potential incremental risk to aquatic wildlife and humans resulting from exposure to dioxin/furan TEQ and mercury in AOI 4. The 6-Inch Cover alternative would significantly lower the SWA mean PEC-Q value by 33 percent, from approximately 0.30 to approximately 0.20, would lower the SWA TEQ (avian) value by 52 percent, from approximately 329 to approximately 159 ng/kg, and would lower the SWA mercury concentration by 54 percent, from approximately 3.05 mg/kg to approximately 1.41 mg/kg, thereby addressing the approved remedial standard (Table 4-4). In addition, the 6-inch Cover alternative would decrease the percent area of AOI 4 with mean PEC-Q values above 0.33 from 22 percent to 6 percent (Table 4-5).

4.4.2 Long-Term Effectiveness Evaluation for AOI 4

The No Further Action alternative would not effectively achieve the approved remedial standard and so is not expected to be effective in the long term.

The 6-Inch Cover alternative would effectively achieve the approved remedial standard by significantly reducing the mean PEC-Q value and the TEQ and mercury concentrations in sediment in the biotic zone. The placement of the 6-Inch Cover is expected to reduce concentrations of COCs to a depth of approximately 6 to 18 inches below the new mudline. As the remedial action areas are partially surrounded by existing oilfield roads, which would be supplemented by new levees, there generally should be no significant surface water movement across the areas where the 6-Inch Cover would be placed. Periodic flooding is not expected to cause significant erosion in the affected areas and the depth of sediment disturbance—if any occurs—should be

considerably less than the thickness of the mixed cover layer. Existing data indicate that critical shear stresses are exceeded in this portion of AOI 4 only 0.01 percent of the time.

For these same reasons, consolidation of AOI 2 sediments into the area of AOI 4 that is partially surrounded by oilfield roads would be effective and protective over the long term. The dioxins/furans and PCBs currently present in Lockport Marsh and Bayou d'Inde tend to adsorb strongly to sediment particles, particularly where, as here, there is a predominance of fine particles and high total organic carbon. Adsorbed contaminants at concentrations like those observed in Lockport Marsh and Bayou d'Inde tend not to migrate horizontally or vertically in pore water or groundwater; rather, any movement of contaminant mass would result from the effects of water currents, waves, and wind on the sediments. The relevant area is already largely protected from the effects of water currents, waves, and wind by the raised oil field roads, and could be further protected through supplemental levees (i.e., raising the elevation of existing levees and/or building additional levees within the placement area). The potential effects of such forces could be further managed through careful placement of the 6-inch clean sediment (up to 12 inches with overplacement allowance) following the consolidation of the AOI 2 sediments into this location. Further analysis of the details of appropriate cover thickness, placement location and methods, and related issues would occur during remedial design. Monitoring of the area during construction activities would ensure that conditions remained protective.

4.4.3 Reduction of TMV Evaluation for AOI 4

The 6-Inch Cover alternative evaluated for AOI 4 would achieve the approved remedial standard and protect human health and the environment by reducing concentrations of COCs in sediment in the top 6 to 18 inches below the mudline. None of the remedial alternatives evaluated for AOI 4 would reduce the TMV of the hazardous constituents through treatment; rather, the clean sediment or sand cover would be used to reduce the potential exposure of biota to concentrations of COCs in the biotic zone.

4.4.4 Short-Term Effectiveness Evaluation for AOI 4

The short-term effectiveness evaluation considers potential hazards associated with implementation of the remedial alternative, as well as the time required for the remedial alternatives to achieve the approved remedial standard.

Implementation of the No Further Action alternative would not pose any hazards to human health (the community at large or remediation workers) or the environment, although existing ecological risks associated with dioxins/furans and mercury in sediment would remain unabated. The time to achieve effectiveness cannot be evaluated for No Further Action, since the approved remedial standard would not be achieved in any recognized time frame.

The 6-Inch Cover alternative may involve some resuspension of impacted sediment, although the resuspended sediment should be readily contained since the impacted areas are generally isolated from surface water flow. The placement of the clean sediment cover would temporarily disrupt existing benthic habitat. The estimated time to implement the 6-Inch Cover alternative is 7 months.

4.4.5 Implementability Evaluation for AOI 4

The equipment (which could include marsh excavators, hydraulic dredges, and ancillary equipment, such as spray nozzles or energy dissipating devices), and personnel required to place the 6-Inch Cover are available. Recent construction activities in Lockport Marsh have demonstrated the feasibility of building protective temporary sidecast levees, particularly in this area, which is protected by existing roads. The shallow water in AOI 4 would make moving equipment around the AOI more difficult than if the water was deeper, but specialized equipment for working on mud and in shallow water is available on the Gulf Coast. Existing structures, including wells, well platforms, pipelines, and the Interstate 210 bridge, would need to be protected, but the added surcharge load would likely not jeopardize the integrity of these structures. A qualified engineer would review the loading of the cover relative to the design of the existing structures to verify that the cover would not result in adverse effects on these structures. In addition, pertinent aspects of the cover design would be provided to the owners of the existing structures and their review would be requested. The LDOTD, the agency responsible

for the Interstate 210 bridge, has expressed concern in the past about construction in the bridge corridor. If LDOTD objects to the construction of the cover in the bridge corridor, cover material could be placed up to, but not in, the bridge corridor, allowing the thickness of the cover to taper down at its natural angle of repose to a thinner layer with essentially no added material under the bridge.

The exclusion of cover material from the bridge corridor would slightly reduce the effectiveness of the remedial alternative, as up to 7 acres of the 123-acre cover area would be left uncovered.

4.4.6 Cost Evaluation for AOI 4

The estimated cost of the 123-acre 6-Inch Cover alternative is approximately $8.9 million (Table 4-4). The cost estimate assumes that the cover material will be dredged from a local source of sediment, such as the Calcasieu River Ship Channel. Costs would be higher if clean sand had to be purchased from a local borrow source and transported to the Site. The assumed volume of cover material used for the cost estimate is approximately 200,000 cy.

4.4.7 ARARs Evaluation for AOI 4

The ARARs associated with the 6-Inch Cover alternative are the same as those discussed in Section 4.1.7 for In Situ Capping in AOI 1. As the construction of the 123-acre 6-Inch Cover would take place within an area already bounded by roads, the activity should not adversely affect drainage within the floodplain.

5 CONCLUSIONS

Remedial alternatives were developed for each of the four AOIs within the Site. These remedial alternatives focus on AOI-specific risk-related issues, and provide a benefit to the entire Bayou d'Inde Study Area by reducing or eliminating source areas and reducing estimated incremental risks to wide-ranging ecological receptors and humans.

Based on existing information, the range of uncertainty associated with Site data, and the evaluation of Site-related risks, the remedial actions identified in this report were designed to provide ecological and human health benefits and reduce estimated incremental risks to acceptable levels. The following Sections 5.1 through 5.4 summarize the comparative analysis of alternatives for each AOI.

5.1 AOI 1 Comparative Analysis

The In Situ Capping alternative (Option 2) would control exposure to and potential migration of essentially all of the sediment with elevated surface concentrations of PCBs in AOI 1, thereby reducing the SWA PCB concentrations and SWA mean PEC-Q value in AOI 1 and removing a potential source of PCBs to downstream sediments and biota. The positive implications of this important source control activity will be discussed in greater detail in Section 5.5. Mercury and dioxins/furans are not a focus of remedial activities in AOI 1. The cap would resist erosion and would form a protective barrier between the impacted sediment and potential receptors. The cap is estimated to have an insignificant impact on the bathymetry of that segment of Bayou d'Inde.

The larger in situ cap (Option 2) would provide greater certainty of effectiveness in the long term. While the reduction of SWA PCB concentrations for the two in situ cap options is comparable, Option 1 would leave the upstream segment uncapped and potentially subject to erosion of the surface sediment, which would transport PCB contamination downstream and potentially expose sediment with higher PCB concentrations. Under Option 2, all of the sediment with known elevated concentrations of PCBs would be capped and effectively contained and isolated for the long term.

The reduction in SWA mean PEC-Q achieved by the In Situ Capping alternative (Option 2) (53 percent) is essentially equal to the reduction that would be achieved by the

Removal/Backfilling alternative. The In Situ Capping alternative provides this equivalent risk reduction at a quarter of the estimated cost of the Removal/Backfilling alternative ($6.1 million vs. $24.4 million) (Table 4-1). The In Situ Capping alternative also involves less of a short-term increase in resuspension of sediment and potential exposure to PCBs and has a substantially reduced impact on the bank areas of AOI 1, avoiding bank destabilization and erosion. In Situ Capping is more readily implemented than the Removal alternatives in part because it would not require the development of a large area for unloading, dewatering, and staging sediment and loading it onto trucks for off-site disposal. For these reasons, the In Situ Capping alternative (Option 2) is protective of human health and the environment and represents the best balance of effectiveness, implementability, and cost among the remedial alternatives evaluated for AOI 1.

5.2 AOI 2 Comparative Analysis

The Removal alternative (Option 2) would reduce the SWA TEQ concentrations in the lower portion of AOI 2 to approximately 169 ng/kg. Sediment that has accumulated in the lower 5,600 feet of Bayou d'Inde since the previous maintenance dredging activity would be removed, restoring the previously dredged channel in this part of Bayou d'Inde. The current SWA mean PEC-Q value for AOI 2 (0.30) is already in the low risk range, but would be reduced further to 0.24. It is anticipated that this alternative, in conjunction with the remediation of the PPG Canal that is being proposed under a separate program, would result in measurable reductions in concentrations of total TEQ in biota in lower AOI 2, particularly in the tissue of seafood consumed by humans (see Section 5.5). Option 1 would provide long-term effectiveness by removing the most highly contaminated sediments and using biomonitoring to evaluate the extent to which that removal, in conjunction with the response actions in the other AOIs (and in the PPG Canal), resulted in the anticipated reduction in fish and shellfish tissue concentrations over time. Option 2 would provide long-term effectiveness by removing more impacted sediment and thereby increasing the likelihood that TEQ and other constituent concentrations potentially contributing to risk have been removed. For these reasons, the Removal alternative (Option 2) in conjunction with consolidation of the sediment in AOI 4 is protective of human health and the environment and represents the best balance of effectiveness, implementability, and cost among the remedial alternatives evaluated for AOI 2.

5.3 AOI 3 Comparative Analysis

The current SWA mean PEC-Q value in AOI 3 (0.49) is in the indeterminate risk range. The remedial objective for AOI 3 is to reduce the SWA mean PEC-Q values, and SWA mercury, dioxin/furan TEQ, and PCB concentrations. The 39-acre 6-Inch Cover alternative involves the placement of a volume of clean sediment equivalent to a minimum 0.5 feet of cover over 39 acres of AOI 3 fringe marsh. This alternative would reduce the SWA mean PEC-Q value by an anticipated 29 percent from current levels to a mean PEC-Q value of 0.35. This alternative also would reduce SWA mercury, dioxin/furan TEQ, and PCB concentrations by 35 percent, 32 percent, and 30 percent, respectively, from current levels, thereby reducing estimated risks to aquatic-dependent wildlife in AOI 3 by commensurate amounts (Table 4-3). The smaller (27-acre) 6-Inch Cover offers somewhat more modest benefits as compared to the 39-acre 6-Inch Cover. Although the 27-acre 6-Inch Cover would reduce the current SWA mean PEC-Q value from 0.49 to 0.39, approximately twice as much area in AOI 3 (15 percent of AOI 3) would still have mean PEC-Q values greater than 0.56 relative to the results of the 39-acre 6-Inch Cover(8 percent of AOI 3). For these reasons, the 39-acre 6-Inch Cover alternative is protective of human health and the environment and represents the best balance of effectiveness, implementability, and cost among the remedial alternatives evaluated for AOI 3.

5.4 AOI 4 Comparative Analysis

The SWA mean PEC-Q value for AOI 4 is 0.30, which is in the low risk range, but two discrete sub-areas within AOI 4 contain sediments with mean PEC-Q values in the high end of the indeterminate risk range and in the low end of the high risk range. These two sub-areas are identified as the 123-acre area on Figure 3-17. These two sub-areas represent approximately one-quarter of the total area of AOI 4 (123 of 470 acres). The current AOI-wide SWA dioxin/furan TEQ value is 157.5 ng/kg (mammalian TEFs) and the SWA mercury concentration is 3.05 mg/kg. The 123-acre 6-Inch Cover alternative would lower the SWA mean PEC-Q value by 34 percent, the SWA dioxin/furan TEQ value by 52 percent, and the SWA mercury concentration by 54 percent (Table 4-4), and would safely contain the impacted sediment within the two sub-areas. For these reasons, the 123-acre 6-Inch Cover alternative is protective of human health and the environment and represents the best balance of effectiveness, implementability, and cost among the remedial alternatives evaluated for AOI 4. In addition to providing a cost-effective remedy for AOI 4, the 6-Inch

Cover provides an efficient means of managing sediment dredged from AOI 2. Specifically, the 123-acre area to be covered is large enough to accommodate the approximately 100,000 cy to be dredged from AOI 2, and the 6-Inch Cover would provide a dual function of covering the impacted sediment in AOI 4 and containing the sediment from AOI 2. Moreover, the protection afforded by the oilfield roads, and perhaps by supplemental levees, will enhance the long-term effectiveness of the sediment cover.

Placement of sediment removed from AOI 2 into a portion of the 123-acre area in AOI 4 prior to implementation of the 6-Inch Cover alternative will not affect the estimated degree of risk reduction in AOI 4. Estimated average dioxin/furan TEQ concentrations in sediments removed from AOI 2 are similar to dioxin/furan TEQ concentrations in the area in AOI 4 where these materials will be consolidated.

5.5 Site-wide Summary of Costs and Benefits of the Recommended Remedial Alternatives

Based on the CAS analysis, the optimal set of alternatives is as follows:

- In situ capping of approximately 36,000 square yards in AOI 1 using ABM technology
- Removal of approximately 97,000 cubic yards of sediment in AOI 2 between the PPG Canal and the mouth of Bayou d'Inde and consolidation of the sediment into AOI 4
- Placement of a 6-inch cover of clean sediment over approximately 39 acres in AOI 3
- Placement of a 6-inch cover of clean sediment over approximately 123 acres in AOI 4, including sediment consolidated from AOI 2
- A post-remedy biomonitoring program to measure concentrations of PCBs and TEQ in fish and shellfish tissues in Bayou d'Inde.

The recommended set of alternatives would protect human health and the environment by removing, capping, or covering impacted sediments and eliminating or reducing potential exposure pathways from impacted sediments to potential receptors. As applicable to individual AOIs, the proposed remedy would significantly reduce the SWA mean PEC-Q value in individual AOIs, address PCB, dioxin/furan TEQ, and mercury concentrations, and protect specific receptor groups. The proposed remedy achieves the approved remedial standard and ARARs while balancing the following other critical considerations:

- Technical and administrative implementability

- Costs
- Minimizing impacts on existing natural resources
- Maintaining or enhancing hydraulic capacity in Bayou d'Inde (AOIs 1 and 2)

As summarized in Table 5-1 and shown schematically in Figure 5-1, the recommended set of alternatives described in the preceding sections will result in the following benefits to the Site as a whole:

- The Site-wide SWA mean PEC-Q value would be reduced by 33 percent, from a pre-remedy SWA mean PEC-Q of 0.34 to a post-remedy SWA mean PEC-Q of 0.23, well within what EPA has categorized as the "low risk" range. Within each AOI, the AOI-wide SWA mean PEC-Q value is below the 0.33 low risk threshold, except for AOI 3, where the post-remedy mean PEC-Q value of 0.35 is just above this threshold and in the low indeterminate range (Table 4-5). The recommended remedy is therefore protective of the aquatic organisms subgroup within the Site. The greatest reductions in mean PEC-Q levels would be accomplished through the placement of a protective barrier in AOI 1 and the placement of minimum 6-inch clean sediment covers in AOI 3 and AOI 4. Implementation of these alternatives would not require long-term biomonitoring to confirm the effectiveness of the alternatives, given the nature of the ABM technology proposed for AOI 1 and the nature of the sediment cover and overall stability of sediments in AOI 3 and AOI 4 (see Section 3.3.3). The ABM cap in AOI 1 would nonetheless be checked periodically to monitor that there is no unacceptable wear that would reduce the functionality of the cap. The cover placed in AOI 3 and 4 would be evaluated to verify that the placement achieved the objectives of the remedy; long-term monitoring of the cover in AOI 3 and 4 would not be necessary because the elevated concentrations in the biologically available zones of these AOIs would be substantially and permanently reduced by the placement of the cover.
- The same sediment-based actions that would result in the 32 percent reduction in the Site-wide SWA mean PEC-Q value also would result in Site-wide reductions in estimated incremental risks to aquatic-dependent wildlife, as follows:
  - Site-wide estimated incremental risks to piscivorous birds due to exposure to total TEQ would be reduced by approximately 27 percent. As illustrated in Figure 5-1, the post-remedy Site-wide estimated incremental risk level for total

TEQ would be very close to the "low risk" threshold, as defined by EPA. The greatest reductions in total TEQ concentrations would be accomplished through the placement of a protective barrier in AOI 1, the placement of minimum 6-inch clean sediment covers in AOI 3 and AOI 4, and the removal of TEQ-impacted sediments in the lower portion of AOI 2. The effectiveness of the remedial alternatives in reducing total TEQ risks can be assessed using an ongoing biomonitoring program (discussed below).

- Site-wide estimated incremental risks to piscivorous birds due to exposure to mercury would be reduced by approximately 47 percent. As illustrated in Figure 5-1, the post-remedy Site-wide estimated incremental risk level for mercury would be in the "low risk" range, as defined by EPA. The greatest reductions in mercury concentrations would be accomplished through the placement of minimum 6-inch clean sediment covers in the most downstream portions of AOI 3 and in AOI 4.
- Site-wide estimated incremental risks to piscivorous mammals due to exposure to total PCBs (Aroclors) would be reduced by approximately 24 percent. As illustrated in Figure 5-1, the post-remedy Site-wide estimated incremental risk for total PCBs (Aroclors) would be in the low end of the "high risk" range, as defined by EPA. However, the post-remedy Site-wide SWA total PCB (Aroclors) concentration in sediments is approximately 0.16 mg/kg and only a very small percentage of the area within the entire Site would have post-remedy sediment concentrations greater than 0.2 mg/kg. Such concentrations would be well below approved remedial standards at other PCB sites throughout the United States. Risk reduction benefits associated with PCB-focused remedial alternatives in AOI 1 (i.e., the elimination of a potential source of PCBs to downstream biota) are not quantifiable in terms of risk reduction to piscivorous mammals, but reductions are nonetheless expected to be measurable. Additional efforts to reduce estimated incremental risks to piscivorous mammals due to total PCBs (Aroclors) are not warranted and would not be cost-effective, given the already low sediment concentrations of PCBs. The greatest reductions in PCB concentrations would be accomplished through the placement of a protective barrier in AOI 1, the placement of the clean sediment covers in AOI 3 and AOI 4, and the removal of PCB-impacted sediment in the lower portion of AOI 2. The

effectiveness of the remedial alternatives in reducing PCB risks can be assessed using an ongoing biomonitoring program (discussed below).

- Site-wide estimated incremental risks to human health would be reduced by approximately 27 percent, based on predicted reductions in total TEQ concentrations in fish and shellfish from Bayou d'Inde (see Appendix G). More importantly, estimated incremental risks to human health in the lower portion of Bayou d'Inde would be reduced by over 50 percent. Bayou d'Inde is one area where ongoing fish and shellfish tissue collection efforts are focused as part of a larger ongoing Calcasieu Estuary Biomonitoring Program conducted by PPG (PPG 2006, PPG 2007, and PPG 2008). Fish and shellfish tissue collected at a number of sites throughout the Calcasieu Estuary, including two stations within Bayou d'Inde, are analyzed for total TEQ compounds. The Louisiana Department of Health and Hospitals (LDHH), the Louisiana Department of Wildlife and Fisheries (LDWF), and LDEQ use these data to evaluate the need for consumption advisories in the Calcasieu Estuary. From a human health perspective, the overall goal is to eliminate the need for a consumption advisory for PCBs and TCDD-TEQ in Bayou d'Inde, using the advisory protocol developed by the LDHH, as amended. Based on recent data collected at the two stations in Bayou d'Inde (2005 through 2007), the recommended alternatives are anticipated to reduce PCB and TEQ concentrations in seafood caught in Bayou d'Inde to levels that are below the minimum thresholds for imposition of a consumption advisory. This would allow the removal of the current consumption advisory in Bayou d'Inde. A biomonitoring program will be used to assess the degree to which the recommended alternatives reduce PCB and TEQ concentrations in seafood in Bayou d'Inde. Appendix I includes a detailed description of this program.

The biomonitoring program also will be used to assess the degree to which the recommended alternatives in all four AOIs have resulted in ecological risk reductions, discussed above, since the two components of the total TEQ approach, dioxins/furans and PCBs, are also two of the primary risk drivers for potential ecological risks to aquatic-dependent wildlife. Biomonitoring programs can be effective at demonstrating the relationship between sediment and biological tissue concentrations of bioaccumulative

compounds. For example, the PPG Biomonitoring Program currently samples high trophic level fish (i.e., red drum, black drum, spotted and sand seatrout, and southern flounder) and invertebrates (blue crab and shrimp) and analyzes sample tissue for total TEQ compounds. There are two sample locations in Bayou d'Inde. Since the program was modified in 2005 to focus on total TEQ compounds, results to date indicate that total TEQ compounds in fish and invertebrate tissues are, in general, directly proportional to prevailing total TEQ sediment concentrations documented in the areas where samples are collected (PPG 2006, 2007, 2008). Within Bayou d'Inde, total TEQ compounds in fish and invertebrate samples collected from Station 4M (upstream portion of Bayou d'Inde near Highway 108) are more heavily weighted toward PCB-related TEQ compounds, consistent with a PCB source in this area. In contrast, total TEQ compounds in fish and invertebrate samples collected from Station 4L (downstream portion of Bayou d'Inde between the PPG Canal and the mouth of the bayou) indicate an increasing influence from a localized dioxin/furan TEQ source. These high trophic level fish and invertebrate species are consuming prey items that live and forage either wholly or substantially in the sediment and surface water environs of AOIs 1 through 4, and that therefore reflect the current sediment conditions within these AOIs. Sediment-based corrective actions in all four AOIs should therefore be reflected in the tissue concentrations of the fish and invertebrates captured at Stations 4M and 4L.

In the future biomonitoring program, measured percent reductions in total TEQ compounds will be compared to risk reduction goals for wildlife and humans to assess the success of the recommended remedy. Reductions in PCB TEQ levels in sampled fish and invertebrate species are also indicative of overall reductions in Total PCBs measured on an Aroclor basis (see Appendix G). Total PCB Aroclors are a part of the mean PEC-Q metric and are also used to assess risks to piscivorous mammals. Therefore, measured reductions in PCB TEQ levels in sampled fish and invertebrate species will be used to assess the overall effectiveness of the remedy in reducing mean PEC-Q and PCB Aroclor levels.

Post-construction sampling will be conducted to ensure that the proposed corrective actions have been successfully completed as designed. This sampling will focus on documenting that the ABM cap has been installed as designed and that a minimum of 6 inches of cover material has been placed in the designated areas of AOI 3 and AOI 4. Post-dredging surveys in lower AOI 2 also will be completed to ensure that the dredging in the lower

portion of AOI 2 has been completed as designed. A long-term monitoring program for the ABM cap will be designed and implemented to ensure the long-term performance of the cap. Given the overall objective of the sediment cover in AOI 3 and AOI 4 (i.e., reduction of surficial concentrations of contaminants of concern through mixing), a long-term monitoring plan is not needed to ensure the performance of the sediment cover. Appropriate institutional controls will be considered during the design phase to ensure the effectiveness of the proposed remedial actions.

The total cost for the recommended remedy across all AOIs is approximately $25 million. This present-worth cost estimates for the remedial alternatives for the four AOI s are:

- AOI 1 - $6.1 million
- AOI 2 - $5.4 million
- AOI 3 - $4.0 million
- AOI 4 - $8.9 million
- Post-remedy biomonitoring - $0.6 million (5-year program)

5.6 Summary of Natural Resource Impacts

Consistent with LAC 33:VI.509.C.5, this CAS evaluates not only the degree to which the remedial alternatives achieve an appropriate level of risk reduction, but also the degree to which they minimize impacts on natural resources. This analysis involves two components: (1) an analysis of how effective the proposed remedy is at reducing future impacts on natural resources; and (2) an analysis of the impacts on natural resources caused by implementation of the remedy.

In AOI 1, the recommended alternative involves placing an In Situ Cap over essentially all of the impacted sediments to limit exposure to and minimize potential movement of impacted sediment. This alternative, when compared with the removal alternatives, achieves essentially the same level of effectiveness (see Tables 4-1 and Table 4-5) with a lower level of environmental impact. Specifically, the installation of the ABM In Situ Cap would minimize the risk of resuspension and transport of PCB-impacted sediment to downstream habitats and biota. Although the use of the ABM In Situ Cap would disrupt the benthic habitat in this portion of the main channel, it is expected that there would be some sedimentation on top of the cap after its placement. The total area of benthic habitat

covered by the ABM cap would be less than 1 percent of the total Bayou d'Inde study area. In addition, the cap would result in fewer impacts on the bank and riparian habitats than the Removal/Backfilling alternative.

The recommended alternative in AOI 2 would temporarily eliminate 12 acres of benthic habitat as a necessary step to achieve the remedial standard. The quality of the current benthic habitat is already affected by regular high turbidity caused by barge traffic. After the removal action, the affected area would repopulate naturally. In AOI 3, the recommended alternative involves the placement of a 6-Inch Cover over 39 acres of fringe marsh. The AOI 3 fringe marshes provide excellent cover and foraging habitat for piscivorous birds and mammals. The cover placement is oriented toward the open water areas of AOI 3, and the disruption of the associated marsh habitats would be temporary; native flora and fauna are expected to repopulate the affected areas rapidly after the implementation of the remedial action. In addition, the Group anticipates that the application of the cover to some shallow areas of AOI 3 would result in the creation of marsh habitat, which is very beneficial to the Bayou d'Inde and Calcasieu Estuary ecosystems. Environmental impacts associated with the recommended alternative in AOI 4 are similar to AOI 3 in those areas in AOI 4 where habitat characteristics and quality parallel conditions in AOI 3. However, in general, the area to be covered in AOI 4 currently provides lower quality habitat than the cover areas in AOI 3, and the AOI 4 habitat is anticipated to improve in any locations where post-remedy elevations are achieved that allow wetland vegetation to become established.

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TABLES

Table 3-1
Summary of Remedial Alternatives for AOI 1
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Description
No Further Action	No remedial action; this alternative is evaluated as a basis of comparison for the evaluation of the other remedial alternatives.
Monitored Natural Recovery	Collect and analyze sediment in the areas of the Upstream and Downstream Groupings of CAS sediment core locations to evaluate continuing reductions in PCB concentrations in the biologically active zone (approximately the 0 - 0.7 foot interval).
Removal/Capping	Remove 2 feet of sediment (plus 1-foot overdredge allowance) over approximately 1.4 acres in the Downstream Segment (Figure 3-2). Place an Engineered Cap in the same area where sediment was removed: 1.5 feet of filter layer (plus 0.5-foot overplacement) and 0.5 feet of armor layer (plus 0.5-foot overplacement).
Removal/Backfilling	Remove approximately 5 feet of sediment (including the 1-foot overdredge allowance) over approximately 2.8 acres in both the Downstream and Upstream Segments (Figure 3-4). Backfill with approximately the same volume of clean sediment from an unimpacted area of Bayou d'Inde.
In Situ Capping (Option 1)	Place an in situ formed concrete cap, including multiple layers of geotextile over approximately 2.9 acres in the Downstream Segment (Figure 3-2).
In Situ Capping (Option 2)	Place an in situ formed concrete cap, including multiple layers of geotextile over approximately 6.2 acres in AOI 1, including the Upstream and Downstream Segments and the reach between the segments (Figure 3-8).

Table 3-2
Remedial Alternatives Screening for AOI 1
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Screening Criteria					Alternative Retained for Detailed Evaluation
	Effectiveness	Implementability	Infeasible Alternative	Relative Cost	Regulatory Requirements	
No Further Action	No[1]	Not Applicable	No	Not Applicable	No issues	Yes
MNR	Yes - the time required to achieve the approved remedial standard has not been determined.	Yes - Equipment and personnel are readily available to collect and analyze samples.	No	Less than $1 Million	No issues	Yes
Removal/Capping	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available to remove sediment and place an engineered cap. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	Approximately $10 Million	Sediment management[2]	Yes
Removal/Backfilling	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available. Potential issues with bank stability. Must obtain access to properties above high water. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	More than $10 Million	Sediment management[2]	Yes
In Situ Capping (both options)	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available. Must obtain access to properties above high water. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	Less than $10 Million	No issues	Yes

Notes:

The Screening Criteria are fully defined in the *Louisiana Administrative Code* Title 33, Section VI.509.C.2.

[1] The "No Further Action" alternative is to be evaluated in detail as a baseline for comparison despite failing to satisfy the screening criteria.

[2] Sediment removed from AOI 1 will be managed in accordance with applicable solid waste requirements if removed from the AOC.

Table 3-3
Summary of Remedial Alternatives for AOI 2
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Description
No Further Action	No remedial action; this alternative is evaluated as a basis of comparison for the evaluation of the other remedial alternatives.
Adaptive Management/ Biomonitoring	No remedial action is proposed at this time. Remedial actions in AOI 1, AOI 3, and AOI 4, (which are all potential source areas for Contaminants of Concern that may impact biota in AOI 2) are expected to address impacts in AOI 2. The data from the Biomonitoring Program in Lower Bayou d'Inde would be evaluated to determine if remedial actions in the source areas are having the anticipated effect. If reductions in tissue concentrations are not observed in AOI 2, the need for additional remedial action would be evaluated.
Removal (Option 1)	Targeted sediment removal would be used to achieve the Remedial Standard by lowering the surface-weighted average 2,3,7,8-dichlorodibenzodioxin Toxic Equivalent (TEQ) concentration. Approximately 42,000 cy of sediment would be dredged from AOI 2. The dredged sediment may be consolidated and contained within AOI 4 or sent to an off-site landfill for disposal. The extents of the removal areas are shown on Figure 3-10.
Removal (Option 2)	Sediment accumulated since the last maintenance dredging (in 1967) would be removed to lower the surface-weighted average TEQ concentration. Approximately 97,000 cy of sediment would be dredged from AOI 2. The dredged sediment may be consolidated and contained within AOI 4 or sent to an off-site landfill for disposal. The extent of the removal area is shown on Figure 3-13.

Table 3-4
Evaluation of TEQ Values in the Bayou d'Inde Channel Before and After Dredging
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Core Location		Dioxin/Furan TEQ Concentrations (ng/kg)								
		BD31	BD32	BD33	BD34	BD35	BD36	BD44	BD47	BD48
Current Mudline Elevation*		-14.8	-11.4	-6.4	-13.2	-12.3	-11.9	-11.9	-8.1	-9.0
Dredge Depth†		1	1	1	5	1	1	3	1	5
Post-Dredge Elevation		-16	-12	-7	-18	-13	-13	-15	-9	-14
Bottom of Sample Interval										
(cm)	(feet)									
11	0.36	2,551	87	290	1,535	693	1,534	1,086	554	424
41	1.35	229	NA	NA	1,922	NA	257	NA	NA	NA
71	2.33	78	NA	227	2,179	NA	57	8,076	163	1,089
101	3.31	22	NA	NA	775	410	32	154	3	972
131	4.30	NA	53	3	429	176	16	25	3	776
161	5.28	NA	58	1	85	5	NA	NA	NA	712
194	6.36	NA	NA	NA	NA	NA	NA	NA	NS	NA

Notes:

1. Elevations are given in feet, North American Vertical Datum of 1988 (NAVD)
2. The proposed dredging plan (Option 1) is depth-based in areas of known elevated TEQ concentrations. The dredge depth in most of the targeted area is 1 foot (with a 1-foot overdredge allowance). Deeper dredging is proposed in the vicinity of sampling locations BD34, BD44, and BD48. Refer to Figure 3-10 for the plan view representation of the dredging limits.
3. The red lines in this table represent the dredge depth. Values above the red lines are TEQ concentrations in sediment that would be removed by dredging. Values below the red lines are TEQ concentrations in sediment that would remain after dredging.
4. Sampling locations within the dredge area are shown on this table.

* The current mudline elevation is based on tide levels and measurements of water depth during the 2007 sampling event

† Dredge depth and Post-Dredge Elevation are reported to the nearest foot to reflect reasonable precision of dredging.

cm - centimeter

ng/kg - nanogramsTEQ per kilogram of sediment, dry weight

NA - Not analyzed

NS - Not sampled

TEQ - 2,3,7,8-tetrachlorodibenzodioxin toxic equivalent based on 2005 World Health Organization factors for mammals and human health

Table 3-5
Evaluation of TEQ Values in the Bayou d'Inde Channel Before and After Dredging
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

		Dioxin/Furan TEQ Concentrations (ng/kg)						
Core Location		**BD31**	**BD34**	**BD35**	**BD36**	**BD44**	**BD47**	**BD48**
Current Mudline Elevation*		-14.8	-13.2	-12.3	-11.9	-11.9	-8.1	-9.0
Dredge Depth†		1	5	3	3	3	7	6
Post-Dredge Elevation		-15	-18	-15	-15	-15	-15	-15
Bottom of Sample Interval								
(cm)	**(feet)**							
11	0.36	2,551	1,535	693	1,534	1,086	554	424
41	1.35	229	1,922	NA	257	NA	NA	NA
71	2.33	78	2,179	NA	57	8,076	163	1,089
101	3.31	22	775	410	32	154	3	972
131	4.30	NA	429	176	16	25	3	776
161	5.28	NA	85	5	NA	NA	NA	712
194	6.36	NA	NA	NA	NA	NA	NS	NA

Notes:

1. Elevations are given in feet, North American Vertical Datum of 1988 (NAVD)
2. The proposed dredging plan (Option 2) is to dredge the channel to an elevation of -15 feet except in the vicinity of BD34, where the plan is to dredge to a depth of 5 feet below the current mudline. Refer to Figure 3-13 for the plan view representation of the dredging limits.
3. The red lines in this table represent the dredge depth. Values above the red lines are TEQ concentrations in sediment that would be removed by dredging. Values below the red lines are TEQ concentrations in sediment that would remain after dredging.
4. Sampling locations within the dredge area are shown on this table.

* The current mudline elevation is based on tide levels and measurements of water depth during the 2007 sampling event

† Dredge depth and Post-Dredge Elevation are reported to the nearest foot to reflect reasonable precision of dredging. The reasonable minimum dredge depth at BD31 is approximately 0.5 feet. Although the target dredge elevation is -15 feet (with a 1-foot overdredge allowance), the actual dredge depth is assumed to be approximately 1 foot.

cm - centimeter

ng/kg - nanogramsTEQ per kilogram of sediment, dry weight

NA - Not analyzed

NS - Not sampled

TEQ - 2,3,7,8-tetrachlorodibenzodioxin toxic equivalent based on 2005 World Health Organization factors for mammals and human health

Table 3-6
Remedial Alternatives Screening for AOI 2
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Screening Criteria					Alternative Retained for Detailed Evaluation
	Effectiveness	Implementability	Infeasible Alternative	Relative Cost	Regulatory Requirements	
No Further Action	No[1]	Not Applicable	No	Not Applicable	No issues	Yes
Adaptive Management/ Biomonitoring	Uncertain - Sediment with elevated TEQ concentrations would remain in place until biomonitoring results indicated the need for action.	Not Applicable	No	Less than $1 Million (for 5-year program)	No issues	No
Removal (Option 1)	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available. Potential issues with bank stability. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	Less than $10 Million[2]	Sediment management[3]	Yes
Removal (Option 2)	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available. Potential issues with bank stability. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	Less than $10 Million[2]	Sediment management[3]	Yes

Notes:

The Screening Criteria are fully defined in the *Louisiana Administrative Code* Title 33, Section VI.509.C.2.

[1] The "No Further Action" alternative is to be evaluated in detail as a baseline for comparison despite failing to satisfy the screening criteria.

[2] Cost estimates assume sediment would be consolidated within the Area of Contamination in AOI 4. Off-site disposal would raise the costs of both alternatives to greater than $10 million.

[3] Sediment removed from AOI 2 would be managed in accordance with applicable solid waste requirements if removed from the Area of Contamination.

Table 3-7
Summary of Remedial Alternatives for AOI 3
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Description
No Further Action	No remedial action; this alternative is evaluated as a basis of comparison for the evaluation of the other remedial alternatives.
Monitored Natural Recovery	Monitor concentrations of critical Contaminants of Concern in the biologically active depth of sediment (approximately the 0 - 0.7 foot interval) to evaluate continuing reductions in potential impacts.
6-Inch Cover	Place clean sediment (from Bayou d'Inde or another local source) over impacted areas to lower the surface concentrations of COC. A minimum 6-Inch Cover would be placed in such a way to minimize mixing of cover material and native sediment, physical disturbance of unimpacted habitat, and loss of flood-surge capacity in the fringe marshes. The Cover would be placed with minimal construction of additional containment structures. Some mixing of the cover material and native sediment would occur during construction. For evaluation of the alternatives, a mixing ratio of 3-to-1 was assumed (i.e., the concentrations of COCs in surface sediment would be reduced by 75 percent as compared to current conditions). Two cover scenarios were evaluated, one comprising approximately 27 acres and the other comprising approximately 39 acres (Figure 3-16).

Table 3-8
Remedial Alternatives Screening for AOI 3
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Screening Criteria					Alternative Retained for Detailed Evaluation
	Effectiveness	Implementability	Infeasible Alternative	Relative Cost	Regulatory Requirements	
No Further Action	No[1]	Not Applicable	No	Not Applicable	No issues	Yes
MNR	Uncertain - The sedimentation rates may be too low to effectively achieve the approved remedial standard without implementing some other remedial action.	Yes - Equipment and personnel are readily available to collect and analyze samples.	No	Less than $1 Million	No issues	No (due to uncertain effectiveness)
6-Inch Cover (both the 27-Acre and 39-Acre alternatives)	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available to place a protective cover. Must obtain property access for construction. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	Less than $10 Million	No issues	Yes

Notes:

The Screening Criteria are fully defined in the *Louisiana Administrative Code* Title 33, Section VI.509.C.2.

[1] The "No Further Action" alternative is to be evaluated in detail as a baseline for comparison despite failing to satisfy the screening criteria.

Table 3-9
Summary of Remedial Alternatives for AOI 4
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Description
No Further Action	No remedial action; this alternative is evaluated as a basis of comparison for the evaluation of the other remedial alternatives.
6-Inch Cover	Place clean sediment (from a local source, such as the Calcasieu River Ship Channel) over impacted areas to lower the surface concentrations of COC. A minimum 6-Inch Cover would be placed with minimal construction of additional containment structures. Some mixing of the cover material and native sediment would occur during construction. For evaluation of the alternatives, a mixing ratio of 3-to-1 was assumed (i.e., the concentrations of COCs in surface sediment would be reduced by 75 percent as compared to current conditions). The 6-Inch Cover would be placed in the subareas indicated on Figure 3-17. A total of 123 acres of impacted sediment in AOI 4 would be addressed by this remedial alternative.

Table 3-10
Remedial Alternatives Screening for AOI 4
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	Screening Criteria					Alternative Retained for Detailed Evaluation
	Effectiveness	Implementability	Infeasible Alternative	Relative Cost	Regulatory Requirements	
No Further Action	No[1]	Not Applicable	No	Not Applicable	No issues	Yes
MNR	Uncertain - The sedimentation rates may be too low to effectively achieve the approved remedial standard without implementing some other remedial action.	Yes - Equipment and personnel are readily available to collect and analyze samples.	No	Less than $1 Million	No issues	No (due to uncertain effectiveness)
6-Inch Cover	Yes - Specific risk reduction values are discussed in Section 4.	Yes - Equipment and personnel are readily available to place a protective cover. Coordination with the USACE and LDEQ to demonstrate that the substantative requirements of regulatory programs are addressed.	No	Approximately $10 Million	No issues	Yes

Notes:

The Screening Criteria are fully defined in the *Louisiana Administrative Code* Title 33, Section VI.509.C.2.

[1] The "No Further Action" alternative is to be evaluated in detail as a baseline for comparison despite failing to satisfy the screening criteria.

Table 4-1
Cost and Effectiveness Evaluation of Remedial Alternatives for AOI 1
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative		No Further Action	Monitored Natural Recovery	Removal/ Capping	Removal/ Backfilling	In Situ Cap (Option 1)	In Situ Cap (Option 2)
			Assumptions for cost development: 20 sampling locations; 1 event/ year for 5 years; 1 event/5 years through year 30	Remove approximately 18,500 cy of sediment from downstream segment; Place Engineered Cap	Remove approximately 47,000 cy of sediment (upstream and downstream segments); Backfill to current mudline	Place approximately 17,000 sy of Articulated Block Mat to contain impacted sediment in the downstream segment	Place approximately 36,300 sy of Articulated Block Mat to contain impacted sediment in the upstream and downstream segments
Construction Cost		**$0**	**$0**	**$8,400,000**	**$22,200,000**	**$2,600,000**	**$5,100,000**
Non-Construction Cost		**$0**	**$500,000**	**$1,400,000**	**$2,200,000**	**$800,000**	**$1,000,000**
Total Cost		**$0**	**$500,000**	**$9,800,000**	**$24,400,000**	**$3,400,000**	**$6,100,000**
Surface Weighted Average Mean PEC-Q	Before	0.47	0.47	0.47	0.47	0.47	0.47
	After	0.47	*	0.26	0.22	0.26	0.22
	% Change	0%	*	44%	53%	44%	53%
Surface Weighted Average Mercury Concentration	Before	0.22	0.22	0.22	0.22	0.22	0.22
	After	0.22	*	0.20	0.19	0.20	0.19
	% Change	0%	*	9%	14%	9%	14%
Mercury Risk to Piscivorous Birds % Change	AOI	0%	*	8.3%	13%	8.3%	13%
	Bayou-Wide	0%	*	0.32%	0.50%	0.32%	0.50%
Surface Weighted Average Dioxin/Furan Bird TEQ	Before	45	45	45	45	45	45
	After	45	*	43	41	43	41
	% Change	0%	*	4.9%	10%	4.9%	10%
Surface Weighted Average Aroclor 1254/1260 Concentration	Before	0.308	0.308	0.308	0.308	0.308	0.308
	After	0.308	*	0.120	0.082	0.120	0.082
	% Change	0%	*	61%	73%	61%	73%
PCB Risk to Piscivorous Mammals % Change	AOI	0%	*	45%	55%	45%	55%
	Bayou-Wide	0%	*	1.8%	2.1%	1.8%	2.1%
Total TEQ Risk to Piscivorous Birds % Change	AOI	0%	*	30%	37%	30%	37%
	Bayou-Wide	0%	*	1.2%	1.4%	1.2%	1.4%
Total TEQ Risk to Human Health % Change	AOI	0%	*	22%	27%	22%	27%
	Bayou-Wide	0%	*	0.9%	1.1%	0.9%	1.1%

Notes:

The cost estimates are presented in greater detail in Appendix F.

Mercury and Aroclor concentrations are reported in milligrams of constituent per kilogram of sediment

TEQ concentrations are reported in nanograms per kilogram

* "After" values are unknown for the Monitored Natural Recovery remedial alternative

Table 4-2
Cost and Effectiveness Evaluation of Remedial Alternatives for AOI 2
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative		**No Further Action**	**Removal (Option 1)**	**Removal (Option 2)**
Remedy Description			**Remove approximately 42,000 cy of sediment; consolidate removed sediment in AOI 4.**	**Remove approximately 97,000 cy of sediment; consolidate removed sediment in AOI 4.**
Construction Cost		**$0**	**$1,800,000**	**$3,700,000**
Non-Construction Cost		**$0**	**$1,200,000**	**$1,700,000**
Total Cost		**$0**	**$3,000,000**	**$5,400,000**
Surface Weighted Average Mean PEC-Q	Before	0.30	0.30	0.30
	After	0.30	0.26	0.24
	% Change	0%	14%	22%
Surface Weighted Average Mercury Concentration	Before	1.19	1.20	1.20
	After	1.19	0.79	0.68
	% Change	0%	34%	43%
Mercury Risk to Piscivorous Birds % Change	AOI	0%	32%	41%
	Bayou-Wide	0%	4.5%	5.7%
Surface Weighted Average Dioxin/Furan Bird TEQ	Before	382	382	382
	After	382	169	145
	% Change	0%	56%	62%
Surface Weighted Average Aroclor 1254/1260 Concentration	Before	0.187	0.187	0.187
	After	0.187	0.127	0.116
	% Change	0%	32%	38%
PCB Risk to Piscivorous Mammals % Change	AOI	0%	24%	28%
	Bayou-Wide	0%	3.3%	4.0%
Total TEQ Risk to Piscivorous Birds % Change	AOI	0%	27%	32%
	Bayou-Wide	0%	3.8%	4.5%
Total TEQ Risk to Human Health % Change	AOI	0%	30%	32%
	Bayou-Wide	0%	4.2%	4.6%

Notes:

The cost estimates are presented in greater detail in Appendix F.

Mercury and Aroclor concentrations are reported in milligrams of constituent per kilogram of sediment

TEQ concentrations are reported in nanograms per kilogram

Table 4-3
Cost and Effectiveness Evaluation of Remedial Alternatives for AOI 3
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative		**No Further Action**		
Remedy Description			**Place clean sediment (volume equivalent to 0.5-foot cover) over 27 acres**	**Place clean sediment (volume equivalent to 0.5-foot cover) over 39 acres**
Construction Cost		**$0**	**$2,200,000**	**$2,900,000**
Non-Construction Cost		**$0**	**$900,000**	**$1,100,000**
Total Cost		**$0**	**$3,100,000**	**$4,000,000**
Surface Weighted Average Mean PEC-Q	Before	0.49	0.49	0.49
	After	0.49	0.39	0.35
	% Change	0%	20%	29%
Surface Weighted Average Mercury Concentration	Before	1.51	1.51	1.51
	After	1.51	1.02	0.98
	% Change	0%	32%	35%
Mercury Risk to Piscivorous Birds % Change	AOI	0%	30%	33%
	Bayou-Wide	0%	5.8%	6.3%
Surface Weighted Average Dioxin/Furan Bird TEQ	Before	153	153	153
	After	153	107	104
	% Change	0%	30%	32%
Surface Weighted Average Aroclor 1254/1260 Concentration	Before	0.263	0.263	0.263
	After	0.263	0.219	0.185
	% Change	0.0%	17%	30%
PCB Risk to Piscivorous Mammals % Change	AOI	0.0%	13%	22%
	Bayou-Wide	0.0%	2.4%	4.3%
Total TEQ Risk to Piscivorous Birds % Change	AOI	0.0%	15%	21%
	Bayou-Wide	0.0%	2.8%	4.1%
Total TEQ Risk to Human Health % Change	AOI	0%	16%	20%
	Bayou-Wide	0%	3.2%	3.8%

Notes:

The cost estimates are presented in greater detail in Appendix F.

Risk reduction ranges for the 6-Inch Cover remedial alternatives are calculated assuming 1-to-3 mixing of capping material and native sediment (75 percent reduction in surface values).

Mercury and Aroclor concentrations are reported in milligrams of constituent per kilogram of sediment

TEQ concentrations are reported in nanograms per kilogram

Capping areas are shown on Figure 3-16

Table 4-4
Cost and Effectiveness Evaluation of Remedial Alternatives for AOI 4
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative		No Further Action	6-Inch Cover (123 acres)
Remedy Description			**Place clean sediment (volume equivalent to 0.5-foot cover) over 123 acres**
Construction Cost		**$0**	**$7,000,000**
Non-Construction Cost		**$0**	**$1,900,000**
Total Cost		**$0**	**$8,900,000**
Surface Weighted Average Mean PEC-Q	Before	0.30	0.30
	After	0.30	0.20
	% Change	0%	34%
Surface Weighted Average Mercury Concentration	Before	3.05	3.05
	After	3.05	1.41
	% Change	0%	54%
Mercury Risk to Piscivorous Birds % Change	AOI	0%	50%
	Bayou-Wide	0%	31%
Surface Weighted Average Dioxin/Furan Bird TEQ	Before	329	329
	After	329	159
	% Change	0%	52%
Surface Weighted Average Aroclor 1254/1260 Concentration	Before	0.238	0.238
	After	0.238	0.168
	% Change	0%	30%
PCB Risk to Piscivorous Mammals % Change	AOI	0%	22%
	Bayou-Wide	0%	14%
Total TEQ Risk to Piscivorous Birds % Change	AOI	0%	25%
	Bayou-Wide	0%	16%
Total TEQ Risk to Human Health % Change	AOI	0%	26%
	Bayou-Wide	0%	16.0%

Notes:

The cost estimates are presented in greater detail in Appendix F.

Risk reduction ranges for the 6-Inch Cover remedial alternatives are calculated assuming 1-to-3 mixing of capping material and native sediment (75 percent reduction in surface values).

Mercury and Aroclor concentrations are reported in milligrams of constituent per kilogram of sediment

TEQ concentrations are reported in nanograms per kilogram

Table 4-5
Effectiveness Evaluations of Remedial Alternatives
for AOIs 1 Through 4
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Remedial Alternative	SWA Mean PEC-Q	Percent Change in SWA Mean PEC-Q	Percent area within the AOI with Mean PEC-Q values greater than: 0.33	0.56	1.0
AOI 1 (Total Area: 31 acres)					
No Further Action	0.47	-	22%	3%	2%
Removal/ Capping	0.26	44%	18%	2%	1%
Removal/ Backfill	0.22	53%	15%	1%	0%
In Situ Capping (Option 1)	0.26	44%	18%	2%	1%
In Situ Capping (Option 2)	0.22	53%	15%	1%	0%
AOI 2 (Total Area: 100 acres)					
No Further Action	0.30	-	32%	3%	0%
Removal (Option 1)	0.26	15%	30%	0%	0%
Removal (Option 2)	0.21	32%	29%	0%	0%
AOI 3 (Total Area: 145 acres)					
No Further Action	0.49	-	50%	25%	3%
6-Inch Cover (27 Acre)[1]	0.39	20%	44%	15%	0%
6-Inch Cover (39 Acre)[1]	0.35	29%	44%	8%	0%
AOI 4 (Total Area: 470 acres)					
No Further Action	0.30	-	22%	8%	0%
6-Inch Cover (123 Acre)[1]	0.20	34%	6%	0%	0%

Notes:
The No Further Action remedial alternative represents a baseline, or the current condition.
[1] The risk reductions for the 6-Inch Cover remedial alternatives assume a 3-to-1 mixing of capping material to native sediment.
AOI - Area of Investigation
PEC-Q - Probable Effects Concentration Quotient
SWA - Surface Weighted Average

Table 5-1
Effectiveness Evaluations of Remedial Alternatives Bayou-wide
Revised Corrective Action Study Report
Bayou d'Inde (AI 7443)

Parameter	Concentration Range	BAYOU-WIDE INTEGRATED REMEDY	
		Pre-Remedy	Proposed Remedy[1]
Mean PEC-Q	*SWAC*[2]	***0.34***	***0.23 (33.3%)***
		Percent area within the AOI with mean PEC-Q values in the specified range	
	> 0.33	29%	17%
	>0.56	10%	3%
	> 1.0	1%	0%
Dioxin/Furan SWA[2] TEQ (birds, ng/kg)		***291***	***142 (51.3%)***
Total TEQ Risk to Piscivorous Birds % Change		0%	27%
SWA[2] Mercury (mg/kg)		***2.38***	***1.18 (50.6%)***
Mercury Risk to Piscivorous Birds % Change		0%	47%
SWA[2] Polychlorinated Biphenyl (PCB) (mg/kg)		***0.239***	***0.162 (32.1%)***
PCB Risk to Piscivorous Mammals % Change		0%	24%
Human Health Risk % Change		0%	27%[3]

Notes:

The proposed remedy is:

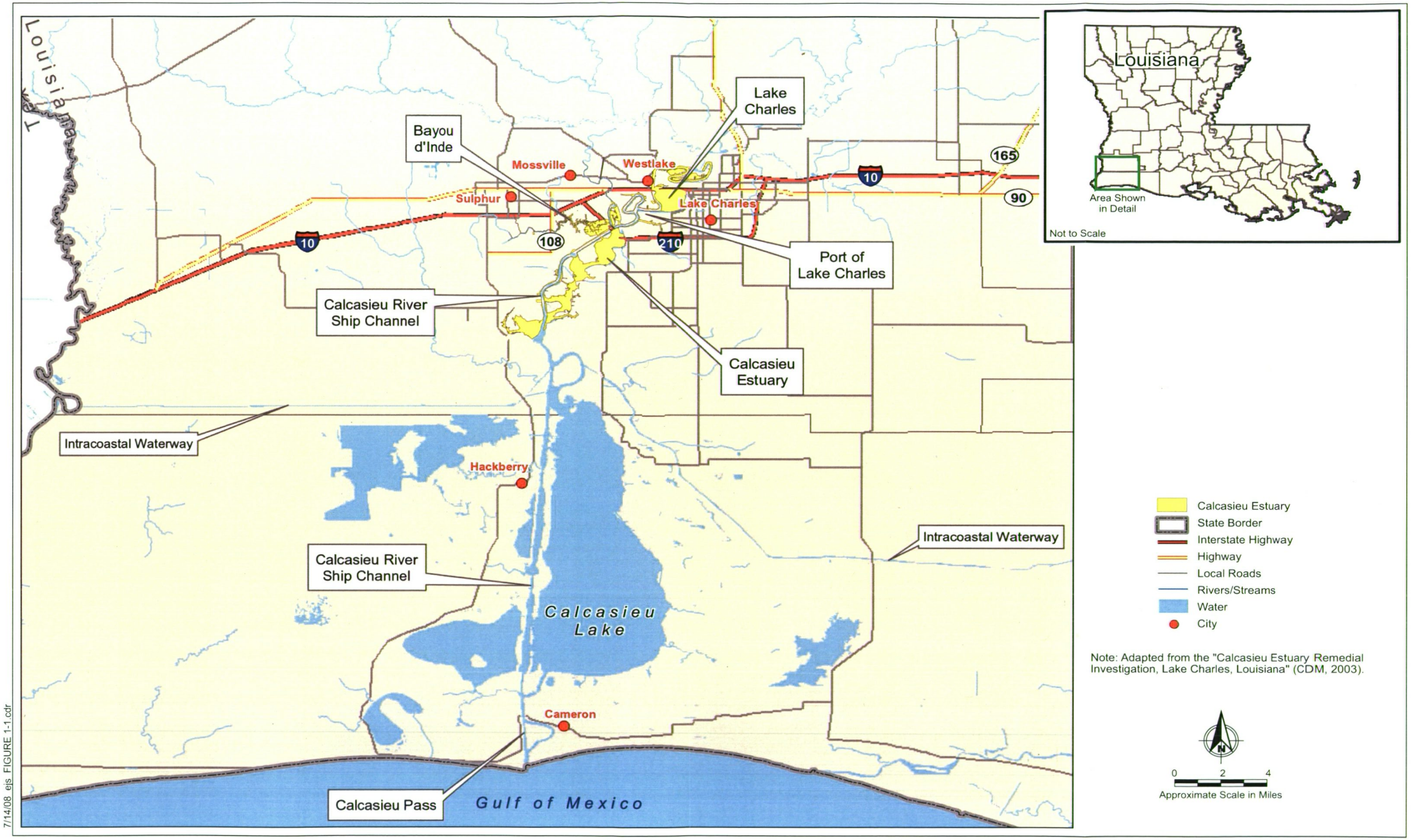
AOI 1: In Situ Capping (Option 2)
AOI 2: Removal (Option 2)
AOI 3: 6-Inch Cover (39 Acre)
AOI 4: 6-Inch Cover (123 Acre)

[1] The risk reductions for the 6-Inch Cover remedial alternatives assume a 3-to-1 mixing of capping material to native sediment.

[2] The values given in this row are the current (pre-remedy) surface-weighted average (SWA) value, the post-remedy SWA value, and the percent reduction.

[3] Human Health risk reduction in Lower AOI 2 is approximately 51%

FIGURES



7/14/08 ejs FIGURE 1-1.cdr

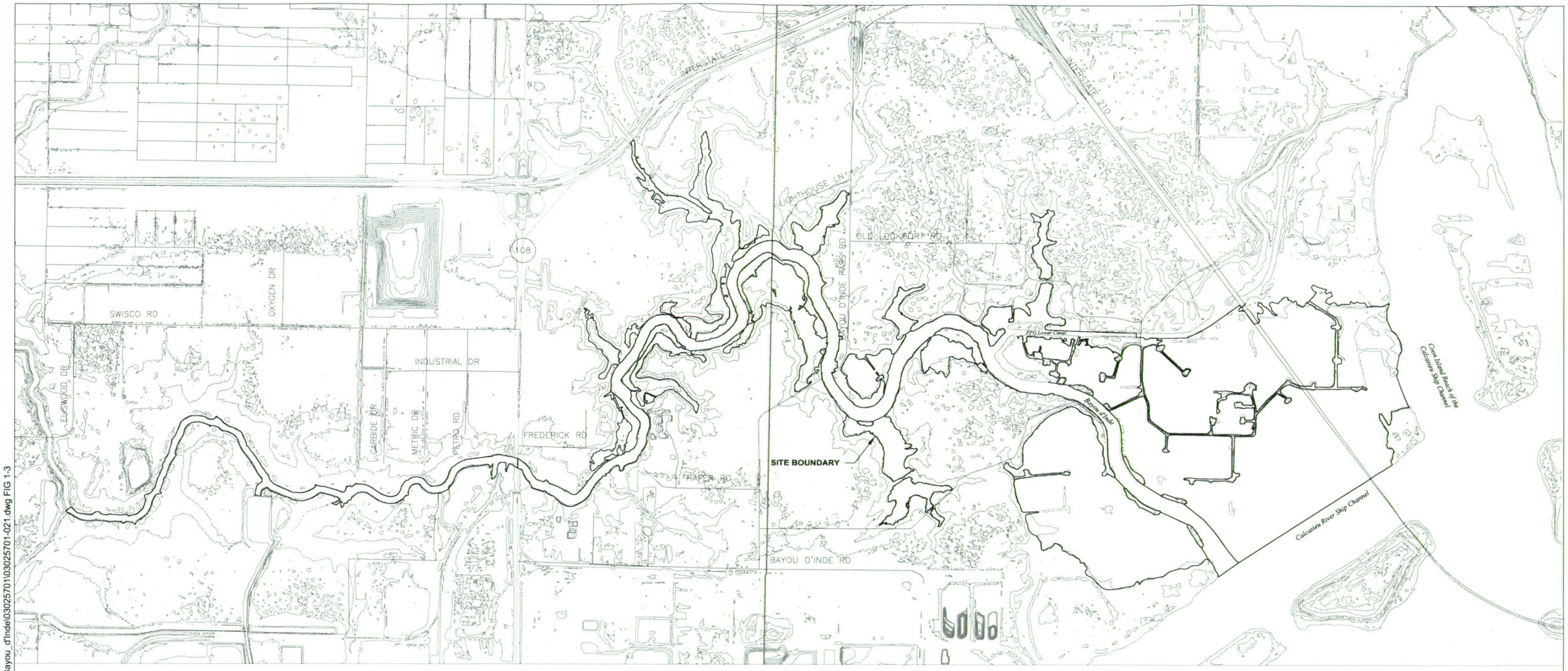
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1-1
Site Location
Corrective Action Study Report
Bayou d'Inde (AI 7443)

7/14/08 ejs FIGURE 1-2.cdr

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1-2
Bayou d'Inde and Surrounding Areas
Corrective Action Study Report
Bayou d'Inde (AI 7443)



LEGEND

TOPOGRAHIC CONTOURS IN FEET

SITE BOUNDARY

NOTES:
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 5 FEET
3. VERTICAL DATUM: NAVD 88
4. WESTLAKE, LA QUADRANGLE.

N

0 800 1,600
SCALE IN FEET

Jul 14, 2008 12:58pm cdavidson K:\Jobs\030257-Bayou_d'Inde\0302570110302570 1-021.dwg FIG 1-3

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1-3
Topographic Map of the Bayou d'Inde Area
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

Land Use Zoning Legend *

- Industrial
- City
- Residential
- Agricultural
- Water

* For parcels within the Bayou d'Inde site

Information obtained from Calcasieu Parish geographic information system.

I - 10

I - 10

BAYOU D'INDE PASS

I - 210

SWISCO RD

OXYGEN DR

CARBIDE DR

METRIC DR

PETRO DR

FREDRICK RD

HAFFER RD

BAYOU D'INDE RD

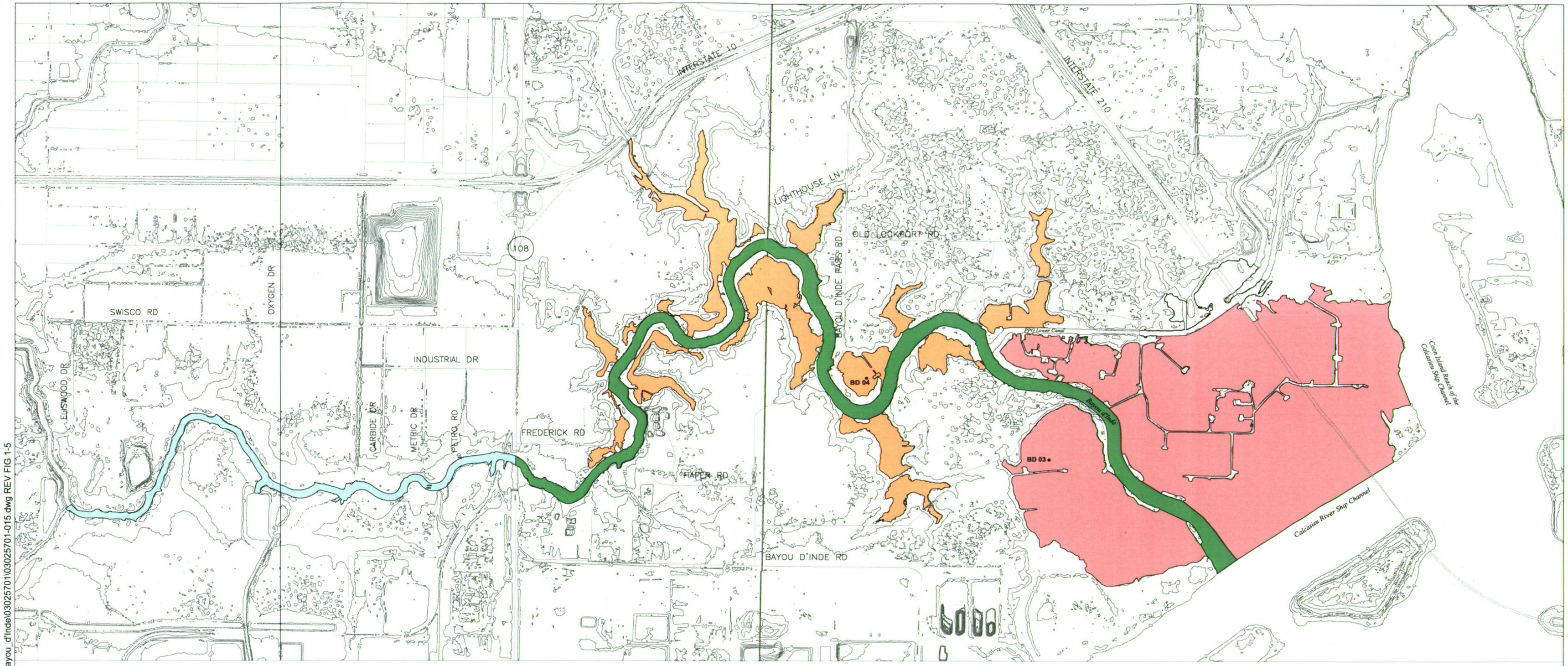
LA 108 HWY

0 500 1,000 2,000 3,000 4,000 Feet

7/14/08 eis Land Use Figure.cdr

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1-4
Zoned Land Uses Near Bayou d'Inde
Corrective Action Study Report
Bayou d'Inde (AI 7443)



AOI-1 (CHANNEL UPSTREAM OF LA 108)

AOI-2 (CHANNEL DOWNSTREAM OF LA 108)

AOI-3 (FRINGE MARSH) - 145 ACRES

AOI-4 (LOCKPORT MARSH) - 470 ACRES

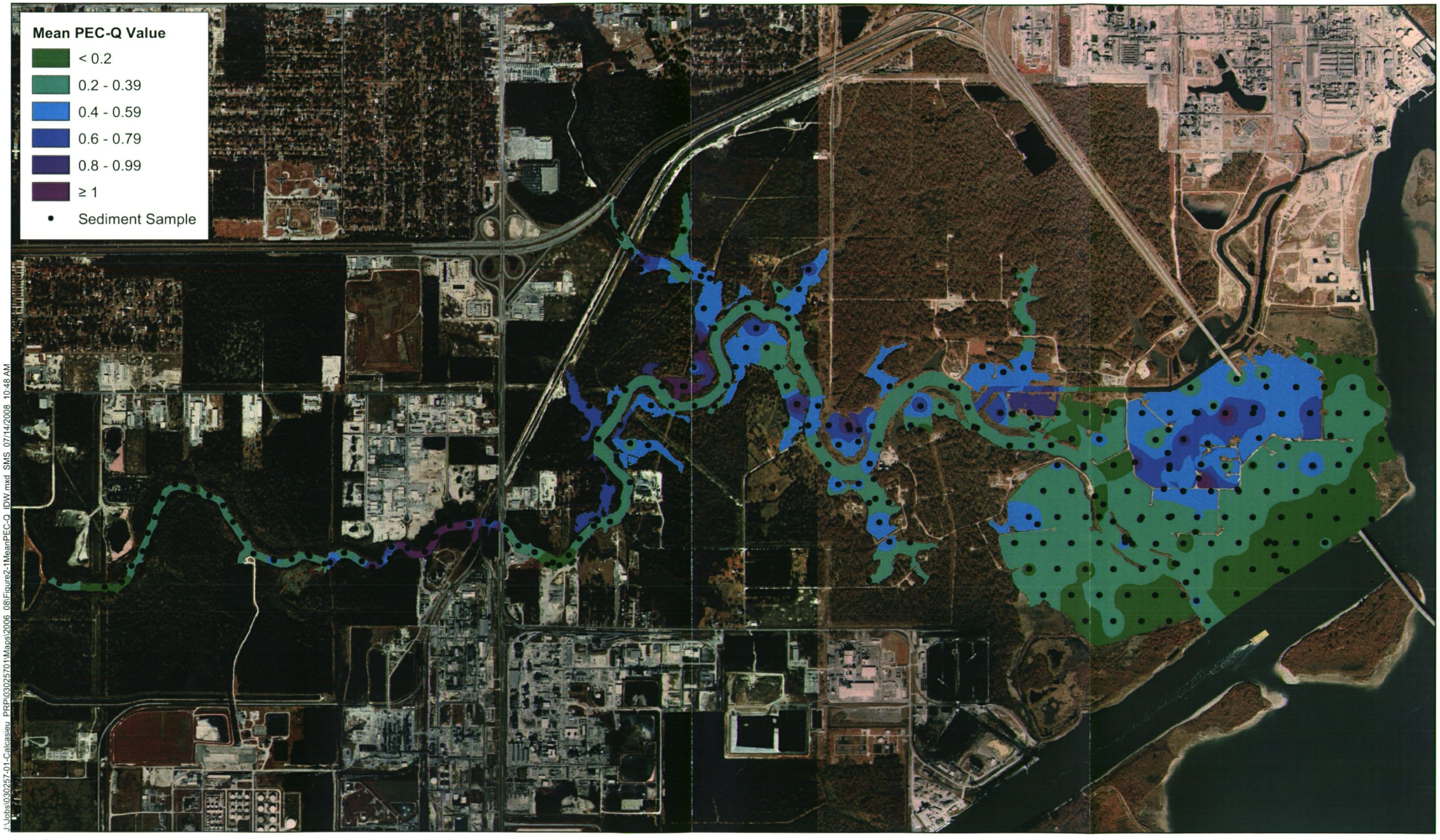
NOTES:
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 5 FEET
3. VERTICAL DATUM: NAVD 88
4. WESTLAKE, LA QUADRANGLE.

N

0 800 1,600
SCALE IN FEET

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1-5
Bayou d'Inde Areas of Investigation
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

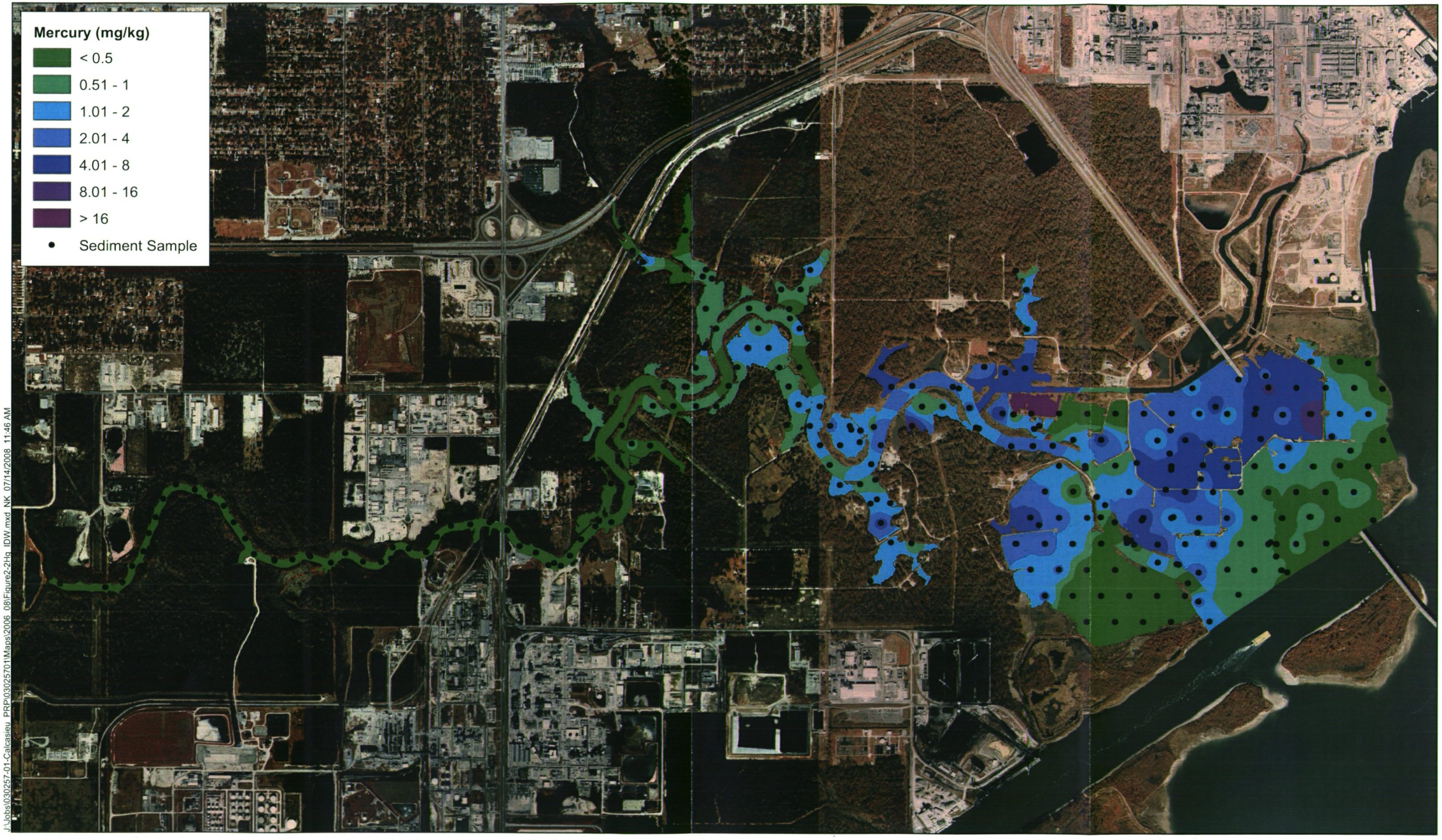


ANCHOR ENVIRONMENTAL, L.L.C.

0 700 1,400 2,800
Feet

The data are from the Remedial Investigation prepared by CDM for EPA Region 6. Samples were collected between December 1999 and December 2000.

Figure 2-1
Mean PEC-Q by Inverse Distance Weighting
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

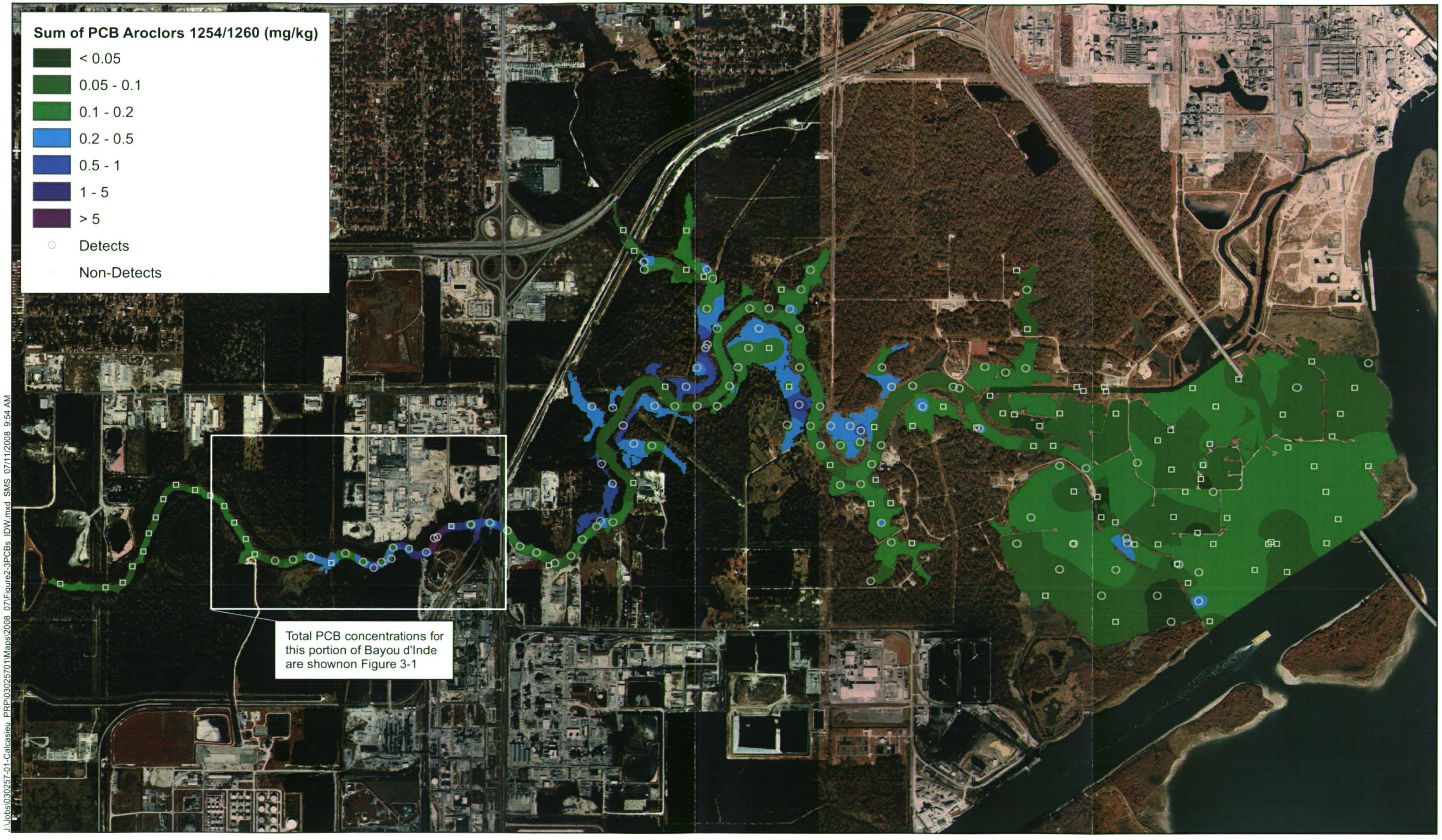


ANCHOR ENVIRONMENTAL, L.L.C.

0 700 1,400 2,800
Feet

The data are from the Remedial Investigation prepared by CDM for EPA Region 6. Samples were collected between December 1999 and December 2000.

Figure 2-2
Mercury Concentration by Inverse Distance Weighting
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



ANCHOR ENVIRONMENTAL, L.L.C.

0 500 1,000 2,000
Feet

The data are from the Remedial Investigation prepared by CDM for EPA Region 6. Samples were collected between December 1999 and December 2000.

Figure 2-3
Sum of Aroclors 1254/1260 Concentration by Inverse Distance Weighting
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

Remedial Investigation sample locations
(CDM, Jan., Nov., & Dec. 2000)

13
41
10
62
34
28
117
7
46
123
181
1378
1814
68
487
82
248
56
9
31
205
92
99
168
2155
808
112
304
56
31
21
163
17
45
876
269
214
11
15
117
6
13
59
15
58
20
11
27
19
5
24
17
32

J:\Jobs\030257-01-Calcasieu_PRP\030257101\Maps\2008_03\Figure2-4_DioxinMammalTEQ.mxd NK 07/14/2008 11:52 AM

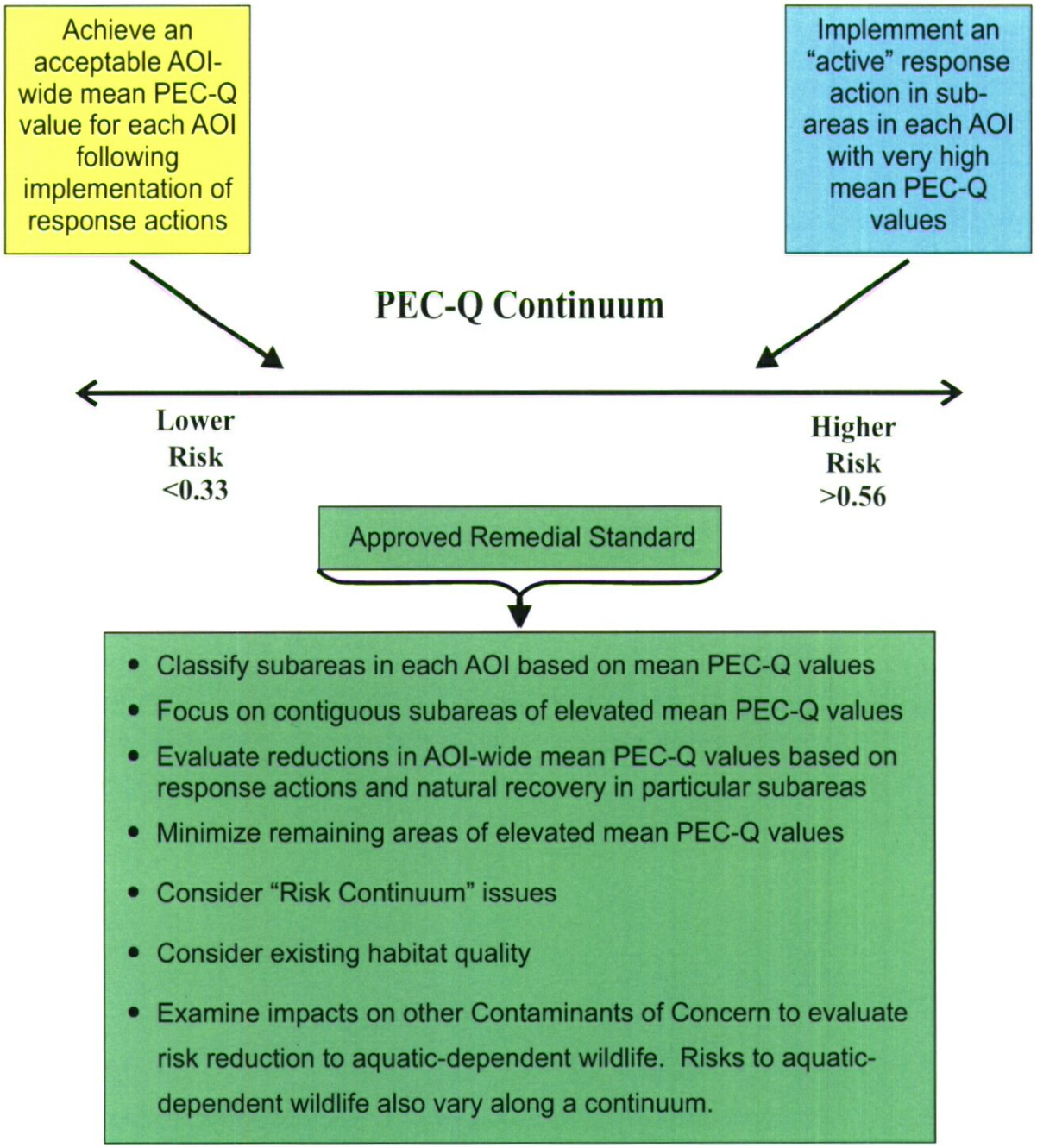
ANCHOR ENVIRONMENTAL, L.L.C.

0 700 1,400 2,800
Feet

N

*The value shown adjacent to sample locations is the 2,3,7,8-tetrachlorodibenzodioxin toxic equivalent (TEQ) based on toxic equivalence factors for mammals

Figure 2-4
Surface Sediment (Dioxin/Furan) TEQ Concentrations
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



7/14/08 eis P:\Projects\Bayou d'Inde\Alt Eval\Report\Figure 2-5.cdr

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2-5
Role of the Mean PEC-Q Metric in the Approved Remedial Standard
Corrective Action Study Report
Bayou d'Inde (AI 7443)

Supplemental Corrective Action Study sediment core locations, June 2007

Corrective Action Study sediment core locations, November 2005

Remedial Investigation sample locations (CDM, Jan., Nov., & Dec. 2000)

Total PCBs (mg/kg)

- < 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1
- 1 - 5
- >5

00BI1-R4018-NSD-010
Aroclor-1254 0.095 LJ
Aroclor-1260 0.19
BIR4-018-SE-CITGO
Aroclor-1254 0.033 U
Aroclor-1260 0.033 U

00BI1-R4026-NSD-010
Aroclor-1254 0.087 U
Aroclor-1260 0.087 U

00BI2-ST005-NSD-010
Aroclor-1254 0.17
Aroclor-1260 0.017 U
00BI2-ST005-NSD2-010
Aroclor-1254 0.53 P
Aroclor-1260 0.025 U

00BI2-R4100-ESD-030
Aroclor-1254 37.9
Aroclor-1260 0.088 U
00BI2-R4100-ESD-060
Aroclor-1254 38.1
Aroclor-1260 0.083 U

00BI1-R4028-NSD-010
Aroclor-1254 0.067 LJ
Aroclor-1260 0.089 U

00BI1-R4019-NSD-010
Aroclor-1254 .061 LJ
Aroclor-1260 .064 U

00BI1-R4023-NSD-010
Aroclor-1254 .090
Aroclor-1260 .069 U

00BI1-R4022-NSD-010
Aroclor-1254 .074 LJ
Aroclor-1260 .082 U

00BI2-R4015-ESD-030
Aroclor-1254 0.28
Aroclor-1260 0.019 U

BD09 BD16 BD22 BD07 BD06 BD50 BD28 BD29 BD08 BD10 BD27 BD26 BD23 BD20 BD17 BD18 BD24 BD25 BD21 BD19 BD15 BD13 BD11 BD12 BD14

00BI1-R4025-NSD-010
Aroclor-1254 0.085 LJ
Aroclor-1260 0.092 U

00BI1-R4027-NSD-010
Aroclor-1254 0.037 LJ
Aroclor-1260 0.041 U

00BI2-ST004-NSD-010
Aroclor-1254 0.071 P
Aroclor-1260 0.016 U

00BI1-R4024-NSD-010
Aroclor-1254 0.1
Aroclor-1260 0.065 U

00BI1-R4014-NSD-010
Aroclor-1254 0.1 U
Aroclor-1260 0.1 U

00BI1-R4017-NSD-010
Aroclor-1254 0.150
Aroclor-1260 0.09 LJ
BIR4-017-SE-CITGO
Aroclor-1254 0.033 U
Aroclor-1260 0.085

00BI1-R4021-NSD-010
Aroclor-1254 0.081 LJ
Aroclor-1260 0.089 U

00BI1-R4015-NSD-010
Aroclor-1254 0.04 LJ
Aroclor-1260 0.066 U
00BI1-R4015-DSD-010
Aroclor-1254 0.052 LJ
Aroclor-1260 0.071 U

00BI1-R4016-NSD-010
Aroclor-1254 .055 LJ
Aroclor-1260 .069 U

00BI2-R4101-ESD-030
Aroclor-1254 0.802
Aroclor-1260 0.08 U

00BI1-R4020-NSD-010
Aroclor-1254 0.062 LJ
Aroclor-1260 0.073 U

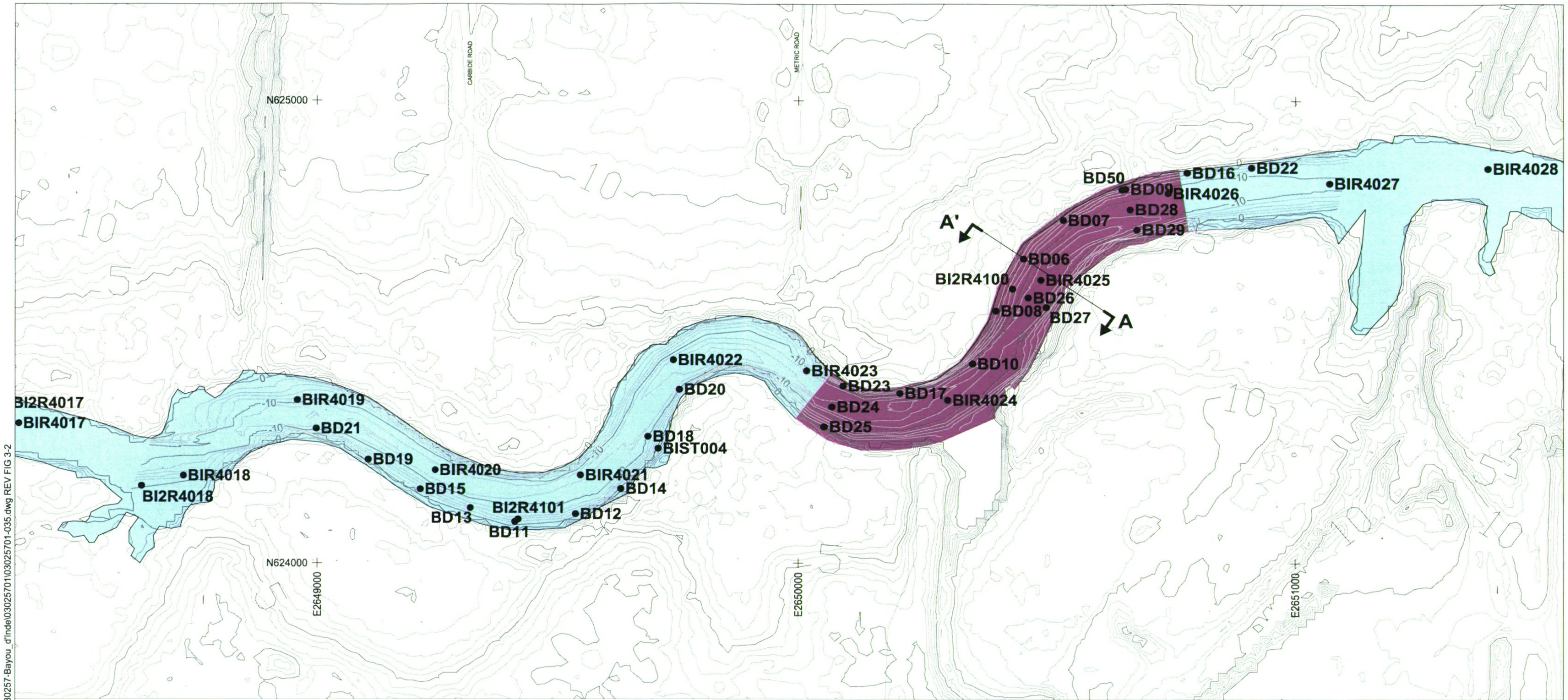
J:\Jobs\0302257-01-Calcasieu_PRP\03025701\Maps\2008_03\3-1_AOI1Sample_locations.mxd NK 07/14/2008 11:54 AM

ANCHOR ENVIRONMENTAL, L.L.C.

0 125 250 500
Feet

The data are from the Remedial Investigation prepared by CDM for EPA Region 6. Samples were collected between December 1999 and December 2000.

Figure 3-1
AOI 1 Total PCB Concentrations
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



•BD24 SAMPLE STATION LOCATION AND NUMBER

LIMITS OF WORK

A A' CROSS SECTION LOCATION

-10 BATHYMETRIC AND TOPOGRAPHIC CONTOURS IN FEET

NOTES:
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 1 FOOT.
3. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2006.
4. BATHYMETRIC CONTOUR INTERVAL: 2 FEET
5. HORIZONTAL DATUM: LOUISIANA STATE PLANE SOUTH, NAD 83 FEET.
6. VERTICAL DATUM: NAVD 88

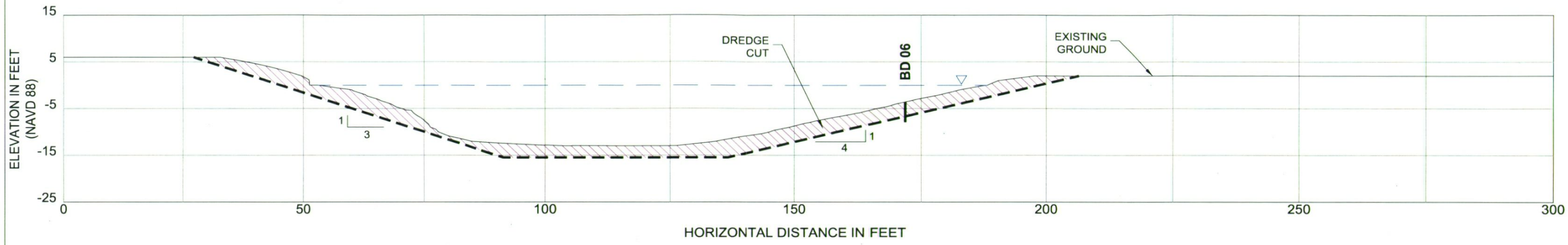
N

0 100 200
SCALE IN FEET

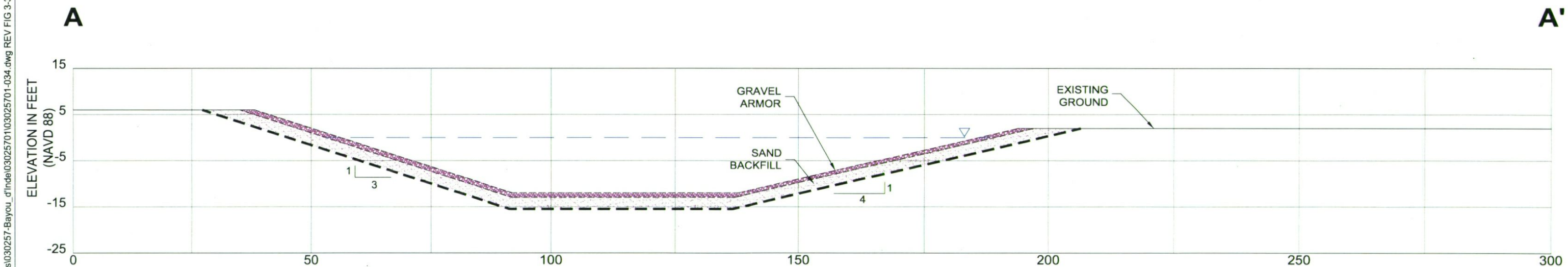
Jul 14, 2008 1:05pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257701\030257701-035.dwg REV FIG 3-2

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-2
Sediment Removal/In Situ Capping in AOI 1, Plan View
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



DOWNSTREAM SECTION A-A'
DREDGE PRISM



DOWNSTREAM SECTION A-A'
POST-DREDGE CAP SECTION

NOTES:

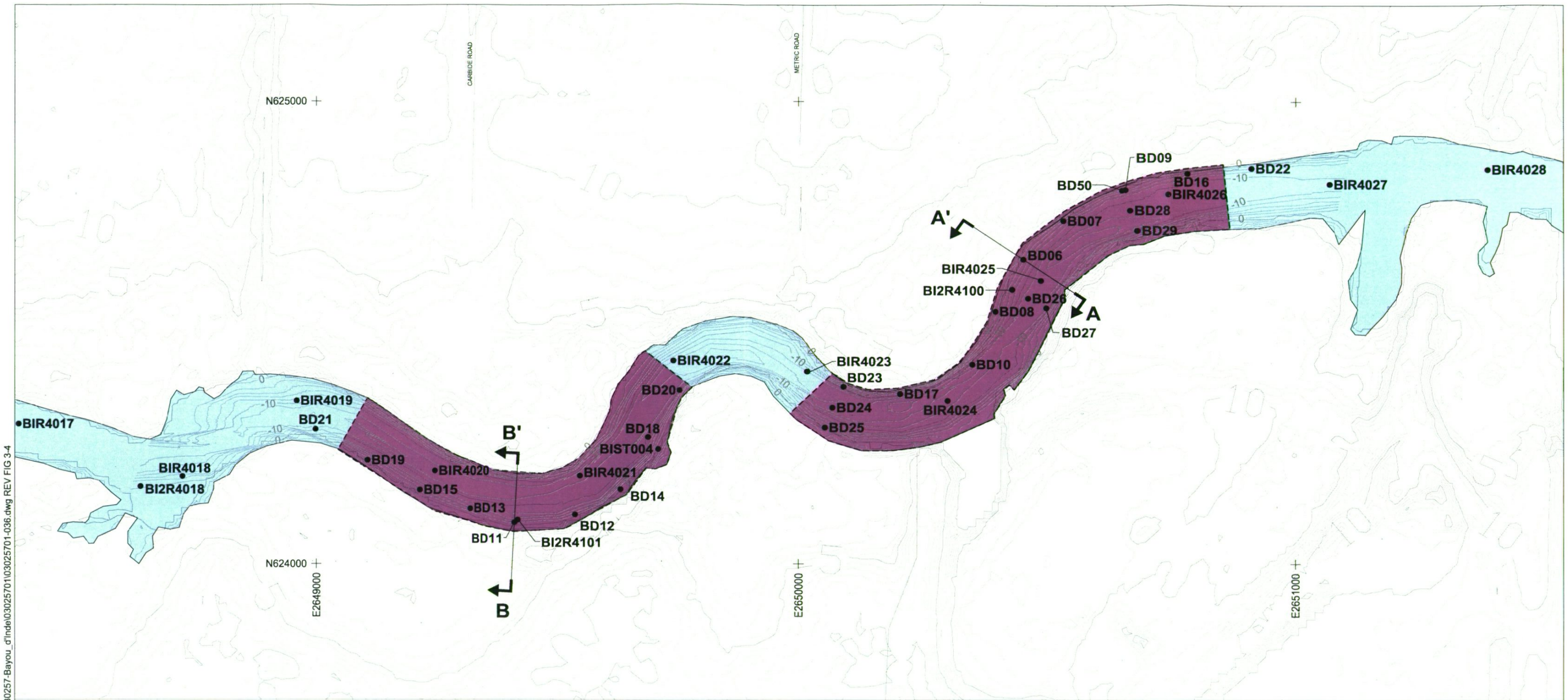
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2006.
3. VERTICAL DATUM: NAVD 88
4. LOCATION OF SECTION IS SHOWN ON FIGURE 3-2.

0 10 20
SCALE IN FEET

Jul 14, 2008 1:07pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257010302570l-034.dwg REV FIG 3-3

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-3
Sediment Removal/Capping in AOI 1, Section A-A'
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



BD 21 • SAMPLE STATION LOCATION AND NUMBER (SAMPLES COLLECTED NOVEMBER 2005)

LIMITS OF WORK

B B' CROSS SECTION LOCATION

-10 BATHYMETRIC AND TOPOGRAPHIC CONTOURS IN FEET

NOTES:
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 1 FOOT.
3. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2006.
4. BATHYMETRIC CONTOUR INTERVAL: 2 FEET
5. HORIZONTAL DATUM: LOUISIANA STATE PLANE SOUTH, NAD 83 FEET.
6. VERTICAL DATUM: NAVD 88

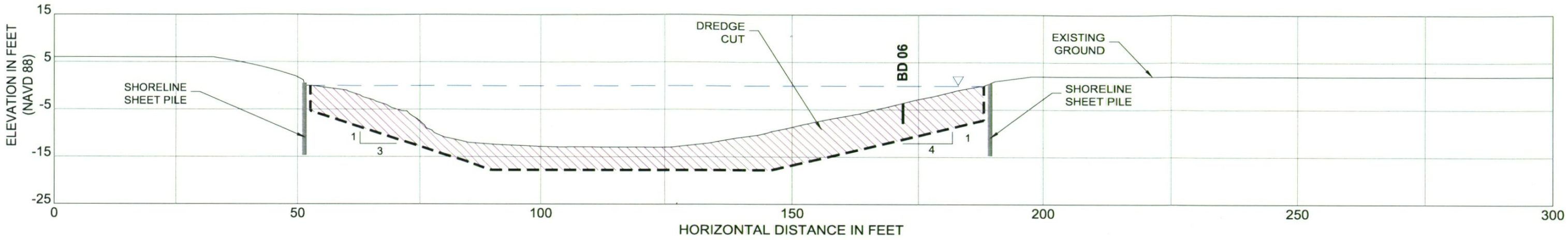
N

0 100 200
SCALE IN FEET

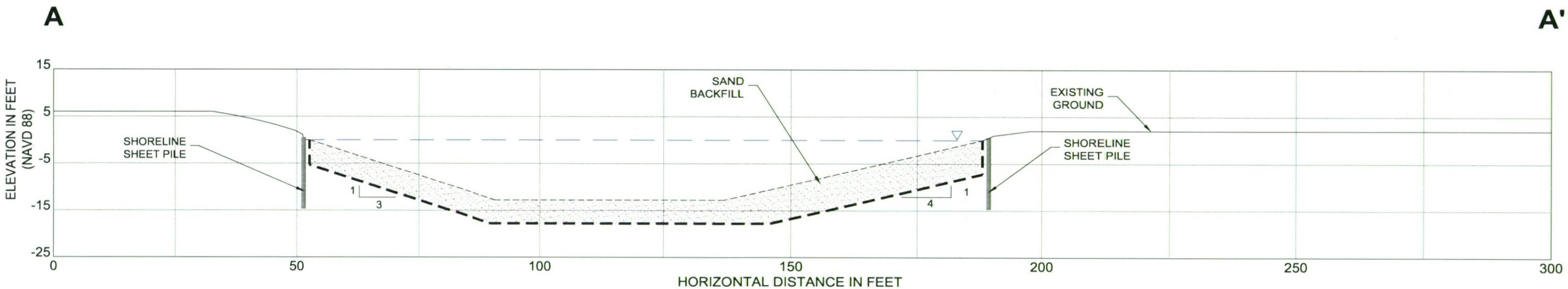
Jul 14, 2008 1:09pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257010302570 1-036.dwg REV FIG 3-4

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-4
Sediment Removal/Backfill in AOI 1, Plan View
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



DOWNSTREAM SECTION A-A'
DREDGE PRISM



DOWNSTREAM SECTION A-A'
POST-DREDGE BACKFILL SECTION

NOTES:

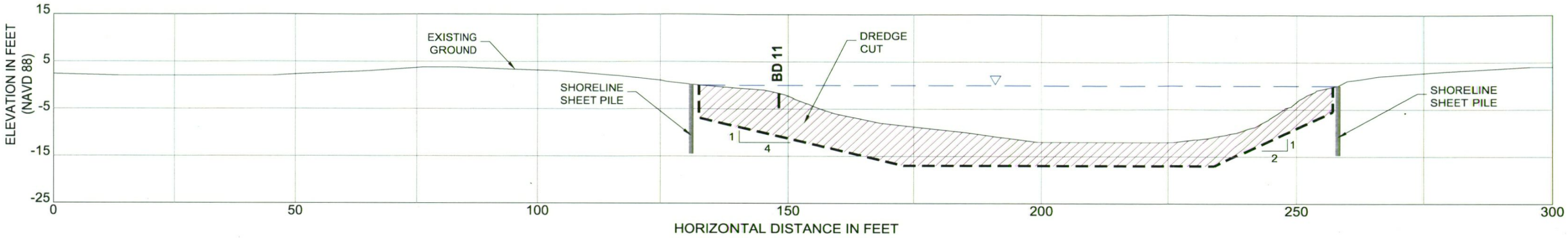
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2006.
3. VERTICAL DATUM: NAVD 88
4. LOCATION OF SECTION IS SHOWN ON FIGURE 3-4.

0 10 20
SCALE IN FEET

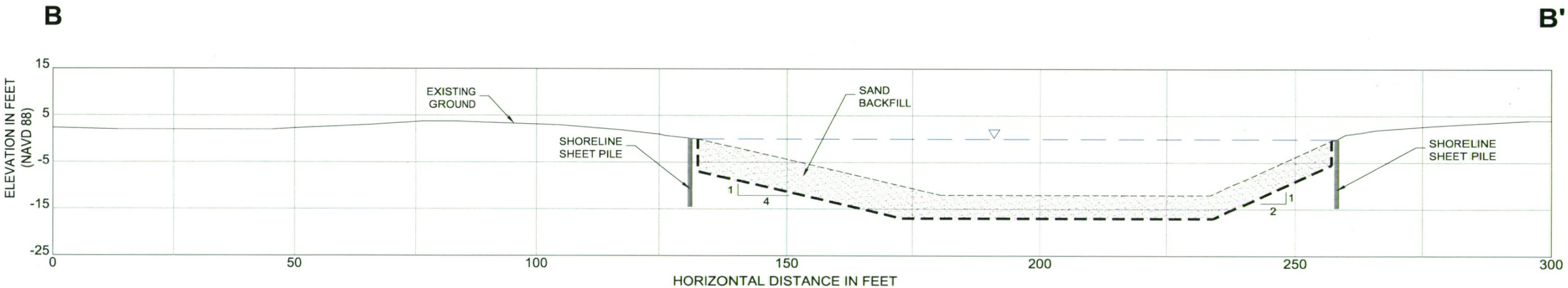
Jul 14, 2008 1:10pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257\0103025701-034.dwg REV FIG 3-5

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-5
Sediment Removal/Backfill in AOI 1, Section A-A'
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



UPSTREAM SECTION B-B'
DREDGE PRISM



UPSTREAM SECTION B-B'
POST-DREDGE BACKFILL SECTION

NOTES:

1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2006.
3. VERTICAL DATUM: NAVD 88
4. LOCATION OF SECTION IS SHOWN ON FIGURE 3-4.

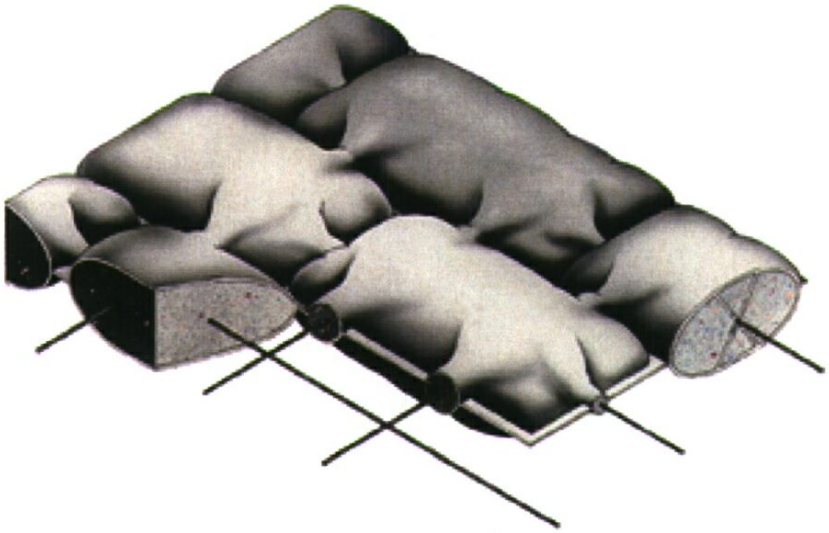
0 10 20
SCALE IN FEET

Jul 14, 2008 1:10pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257010\030257010-034.dwg REV FIG 3-6

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-6
Sediment Removal/Backfill in AOI 1, Section B-B'
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

UNIFORM
SECTION
MAT



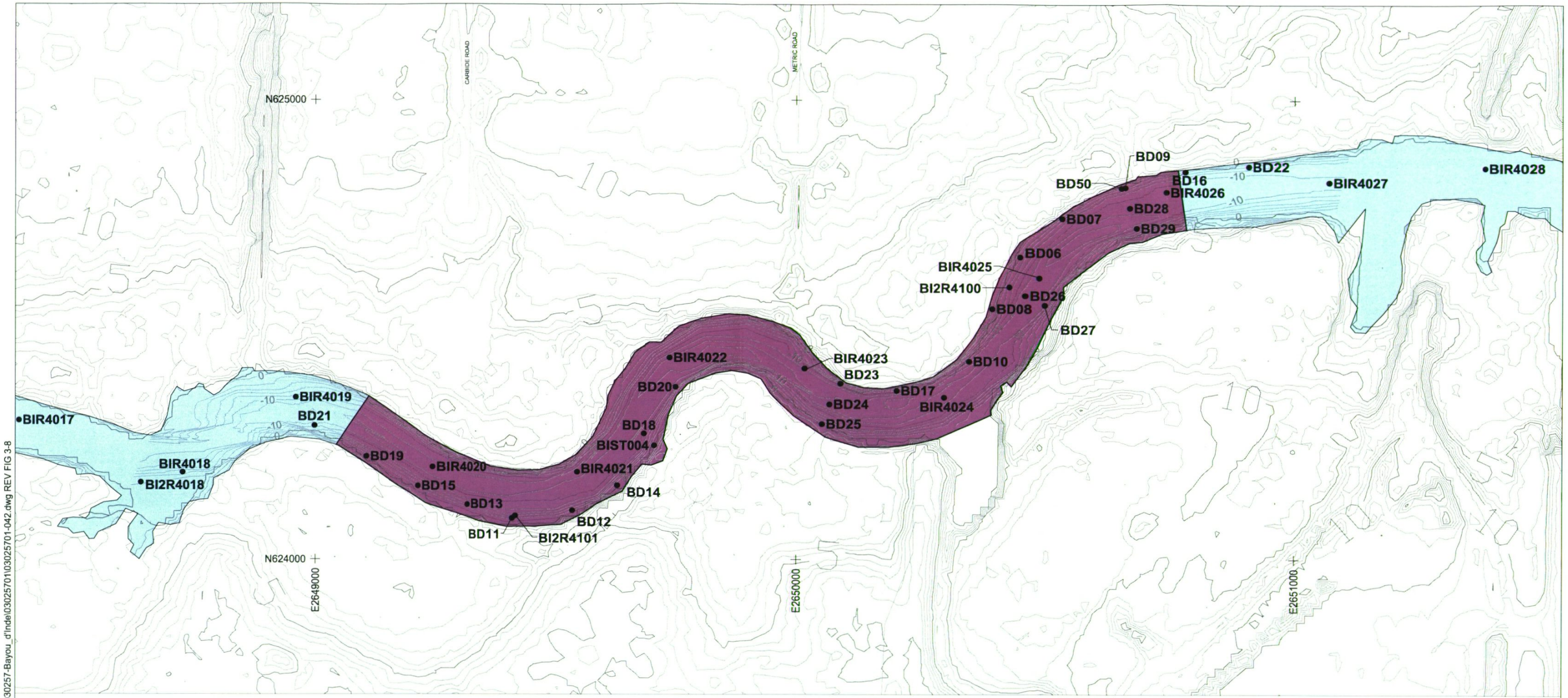
ARTICULATED
BLOCK
MAT

SOURCE DIAGRAM FROM DONNELLY
FABRICATORS, INC. (texicon.com)

7/14/08 eis capping mats.cdr

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-7
In Situ Formed Concrete Mat Examples
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-8
In Situ Capping (Option 2), Plan View
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

Supplemental Corrective Action Study sediment core locations, June 2007

Remedial Investigation, CDM, Jan., Nov.,and Dec. 2000, except for LDEQ3, Anchor, December 2005

IDW of Total Mammalian TEQ (ng/kg)

- < 100
- 101 - 500
- 501 - 1,000
- 1,001 - 2,000
- > 2,000

BIST030 73
BIST011 1571
BIST027 3389
BD30 3
BI2R1003 100
BD31 2685
BD34 1620
BD35 750
BIR1004 2155
BD32 97
BD33 308
BD36 1616
BD37 45
BIST026 134
BD38 378
BD39 454
LDEQ3 7
BD41 5
BD40 509
BI2R1010 311
BD42 5
BIR1010 876
BD44 1150
BI2R1012 238
BD43 10
BD45 289
BD46 29
BD47 585
BD49 124
BD48 445
BIR1015 117

J:\Jobs\030257-01-Calcasieu_PRP\030257101\Maps\2008_05\Figure 3-9.mxd NK 07/14/2008 11:57 AM

ANCHOR ENVIRONMENTAL, L.L.C.

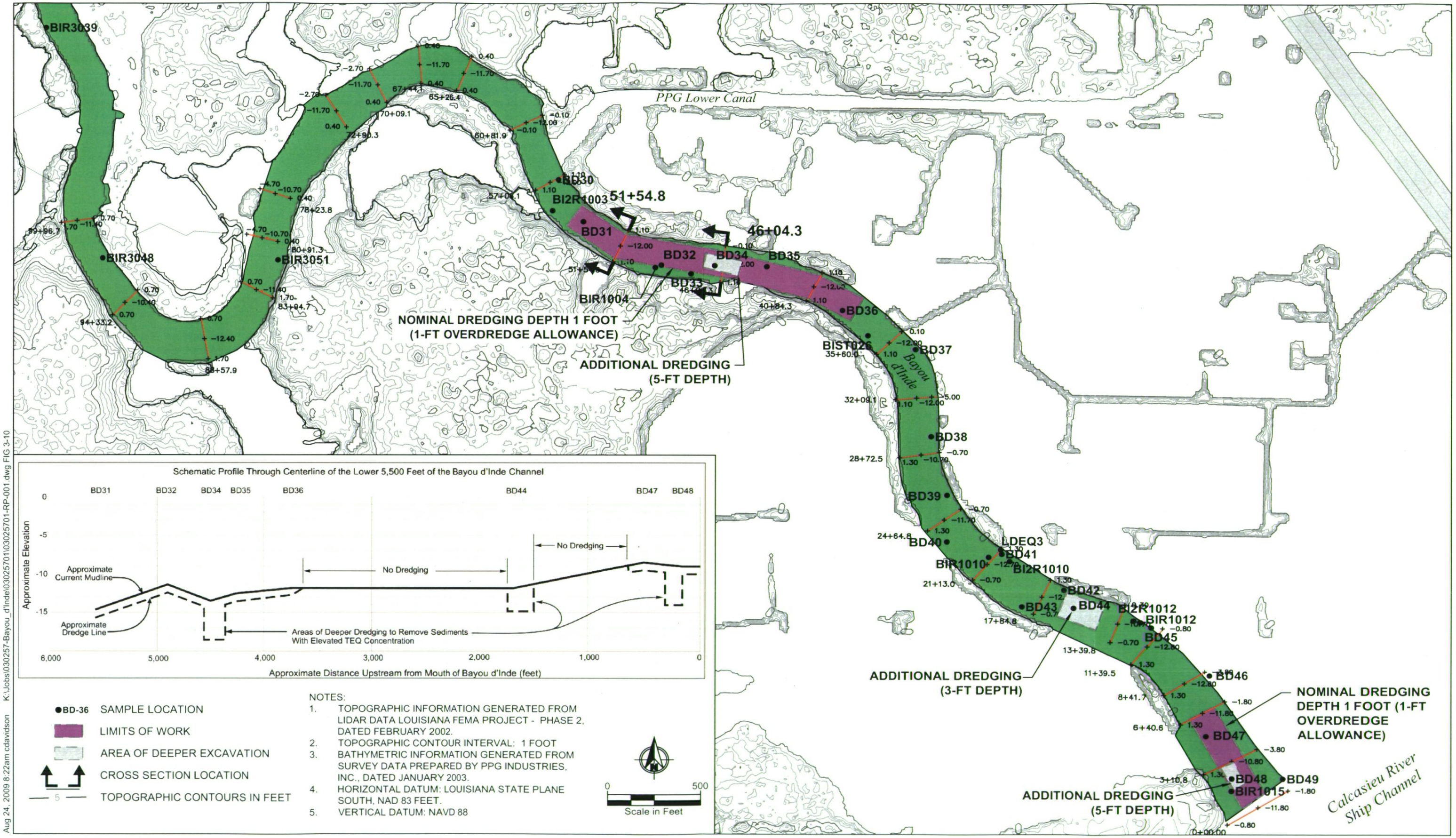
0 125 250 500
Feet

N

The data from the Remedial Investigation prepared by CDM for EPA Region 6. Samples were collected between December 1999 and December 2000.

Values represent Total TEQ (Dioxin/Furan TEQ + PCB congener TEQ), except at locations BIR1004, BIR1010, and BIR1015 where samples were not analyzed for PCBs. TEQ values at these locations are Dioxin/Furan TEQ

Figure 3-9
AOI 2 Total TEQ Concentrations in Surface Sediment
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



Schematic Profile Through Centerline of the Lower 5,500 Feet of the Bayou d'Inde Channel

●BD-36 SAMPLE LOCATION

LIMITS OF WORK

AREA OF DEEPER EXCAVATION

CROSS SECTION LOCATION

5 TOPOGRAPHIC CONTOURS IN FEET

NOTES:

1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 1 FOOT
3. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2003.
4. HORIZONTAL DATUM: LOUISIANA STATE PLANE SOUTH, NAD 83 FEET.
5. VERTICAL DATUM: NAVD 88

0 500

Scale in Feet

Aug 24, 2009 8:22am cdavidson K:\Jobs\030257-Bayou_d'Inde\03025701\03025701-RP-001.dwg FIG 3-10

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-10
Sediment Removal in AOI 2 (Option 1), Plan View
Revised Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

TEQ Concentrations (ng/kg)

	0 - 11 cm			41 - 71 cm			71 - 101 cm			101 - 131 cm		
	bank	channel	bank	bank	channel	bank	bank	channel	bank	bank	channel	bank
BD30	3											
BD31		2,685			98			28				
BD32			97									53
BD33			308			227						3
BD34		1,620			2,265			859			429	
BD35		750						410			176	
BD36		1,616			97			48			16	
BD37	45											
BD38	378			3			2			2		
BD39	454			705			90			6		
BD40			509			637			2			2
BD41	5			5			3			3		
BD42	5			2			1			2		
BD43			10			3			2			1
BD44		1,150			8,076			154			25	
BD45	289			274			241			176		
BD46	29			3			2					
BD47			585			163			3			3
BD48		445			1,089			972			776	
BD49	124			5			5			2		
MINIMUM	3	445	10	2	97	3	1	28	2	2	16	1
MAXIMUM	454	2,685	585	705	8,076	637	241	972	3	176	776	53

LEGEND

- ●BD-36 SAMPLE LOCATION
- APPROXIMATE BOUNDARIES OF 78-FOOT WIDE CHANNEL
- — 5 — TOPOGRAPHIC CONTOURS IN FEET

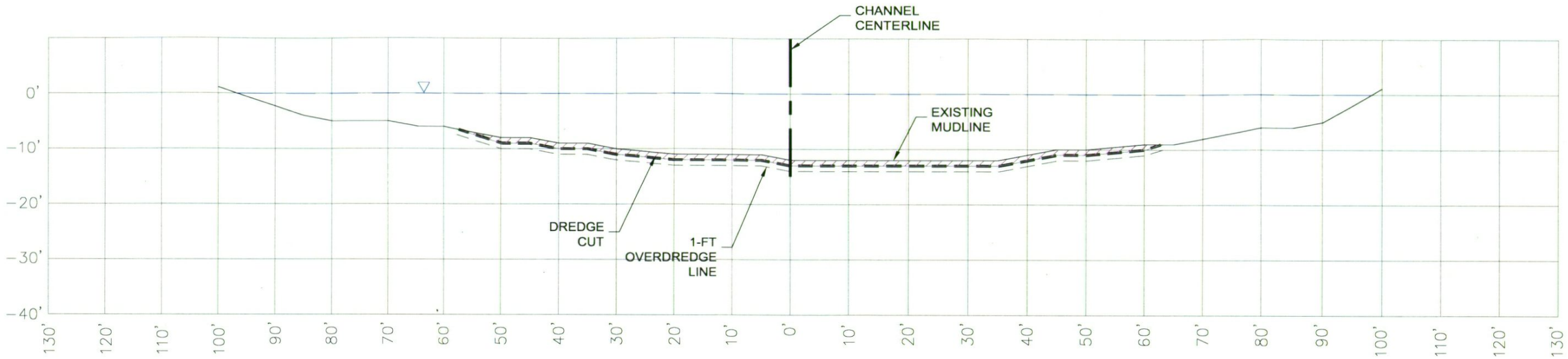
NOTES:
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 1 FOOT
3. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2003.
4. HORIZONTAL DATUM: LOUISIANA STATE PLANE SOUTH, NAD 83 FEET.
5. VERTICAL DATUM: NAVD 88

0 400
Scale in Feet

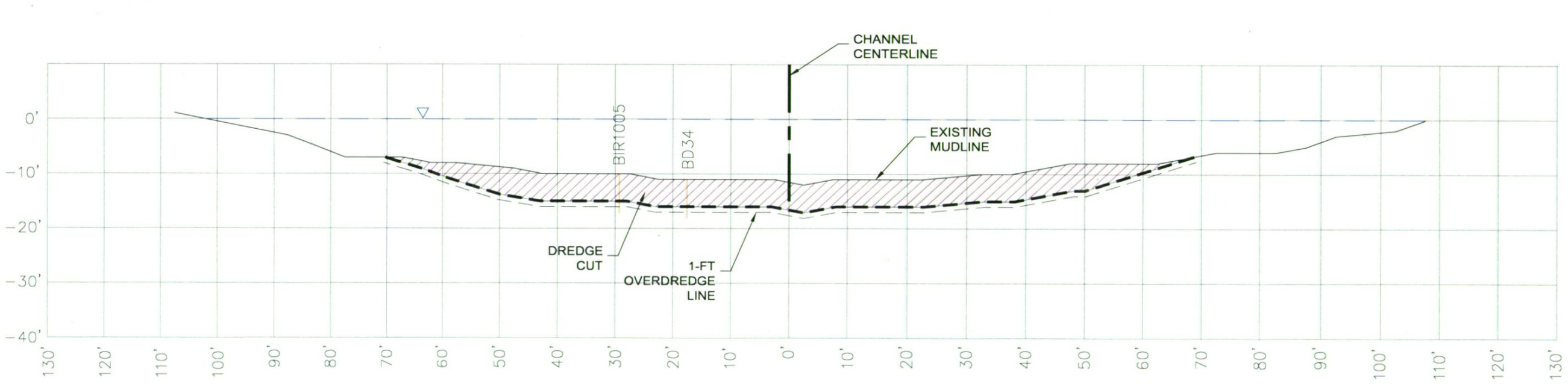
July 14, 2008 ejs Projects\Bayou d'Inde\Att Eval\Report\Rev 1_2007\midchannel eval.cdr (030257O1-031.dwg FIG X)

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-11
Total TEQ Concentrations in AOI 2
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



STA. 51+54.8



STA. 46+04.3

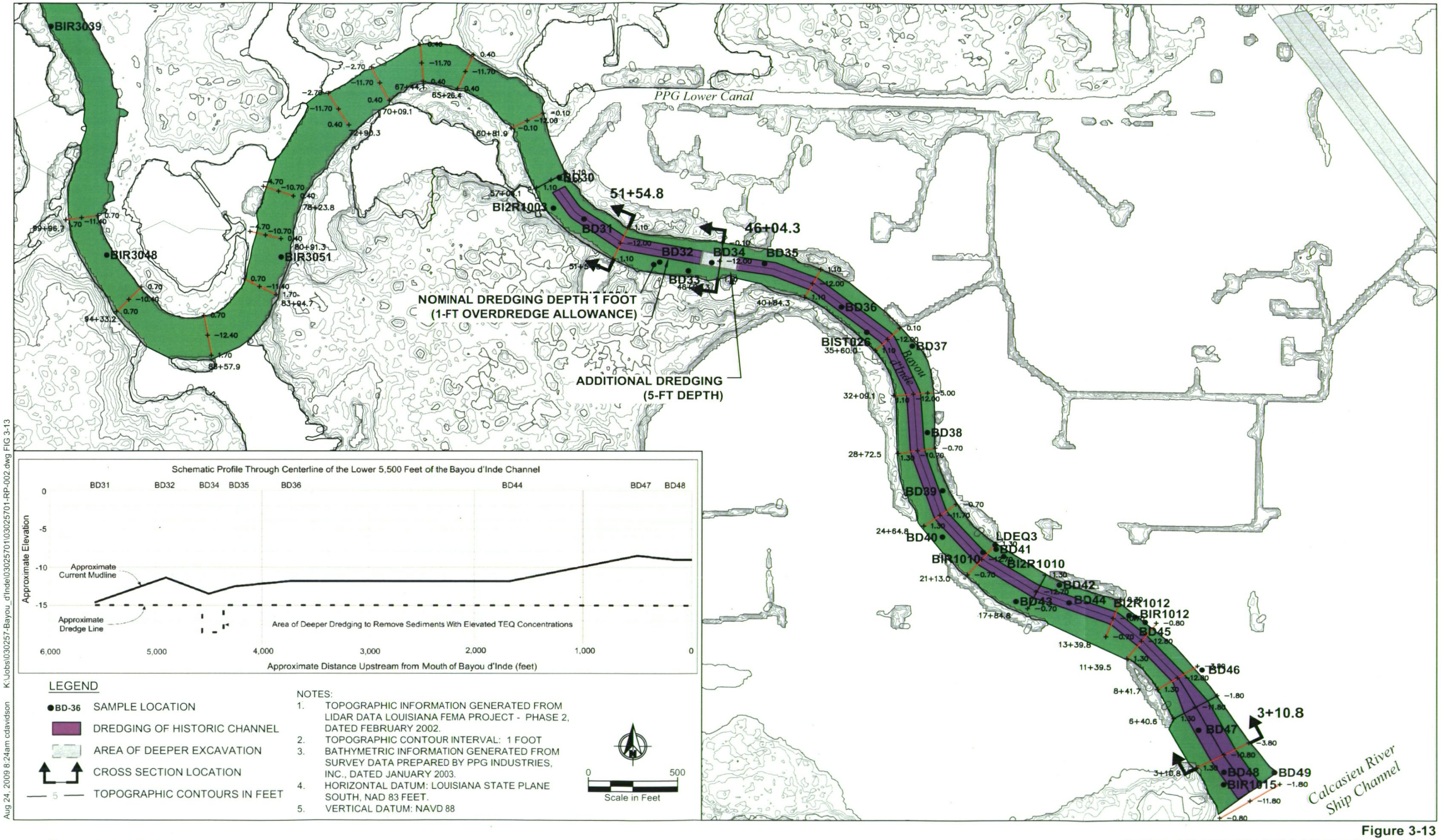
NOTES:
1. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2003.
2. VERTICAL DATUM: NAVD 88
3. LOCATION OF SECTIONS SHOWN ON FIGURE 3-10.

0 10 20
SCALE IN FEET

Jul 14, 2008 1:24pm cdavidson K:\Jobs\0302\57-Bayou_d'Inde\03025701\03025701-043.dwg REV FIG 3-12

ANCHOR ENVIRONMENTAL, L.L.C.

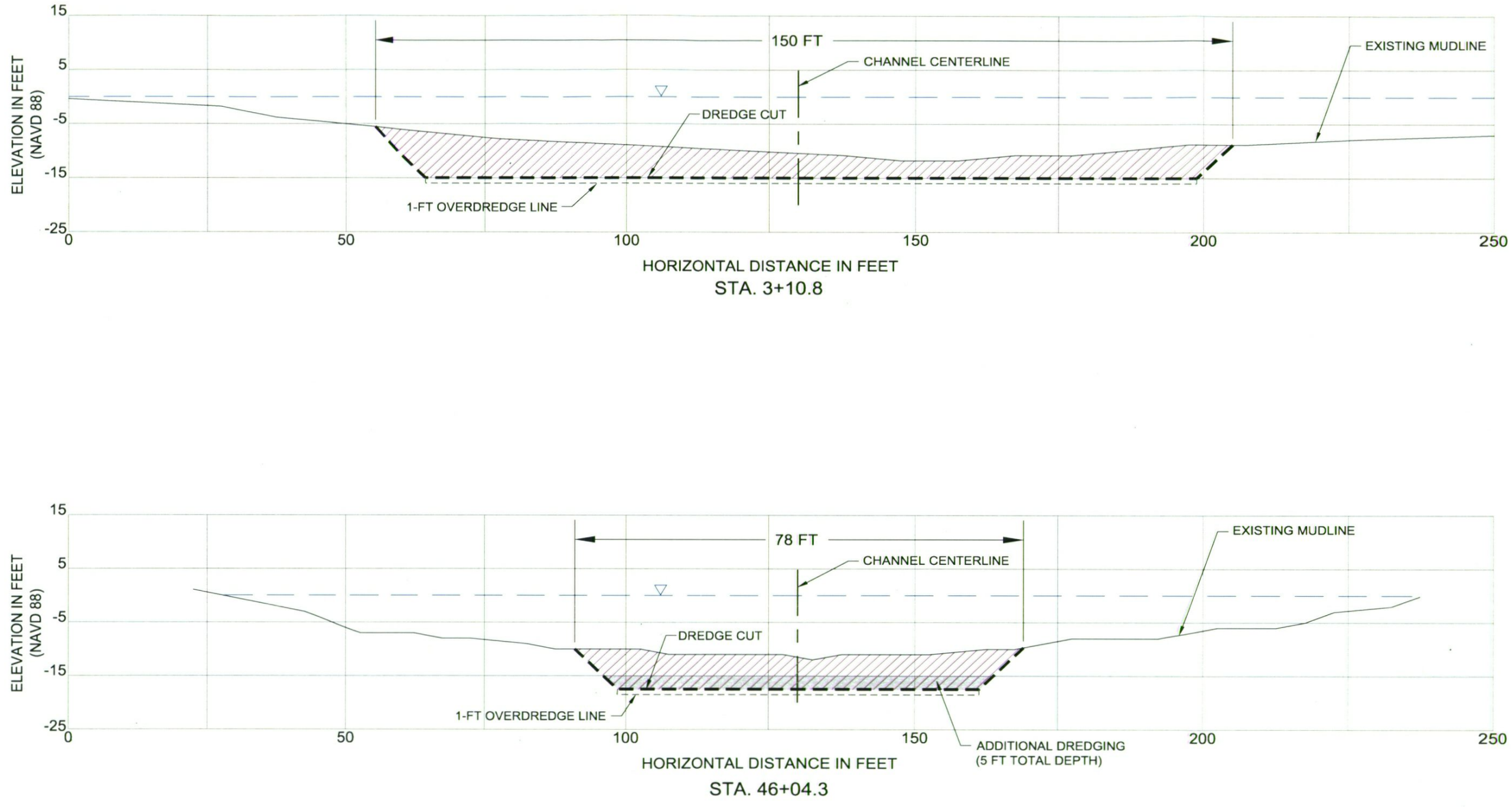
Figure 3-12
Sediment Removal in AOI 2 (Option 1), Cross Sections STA 46+04.3 and STA 51+54.8
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



Aug 24, 2009 8:24am cdavidson K:\Jobs\030257-Bayou_d'Inde\03025701\03025701-RP-002.dwg FIG 3-13

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-13
Sediment Removal in AOI 2 (Option 2), Plan View
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



NOTES:

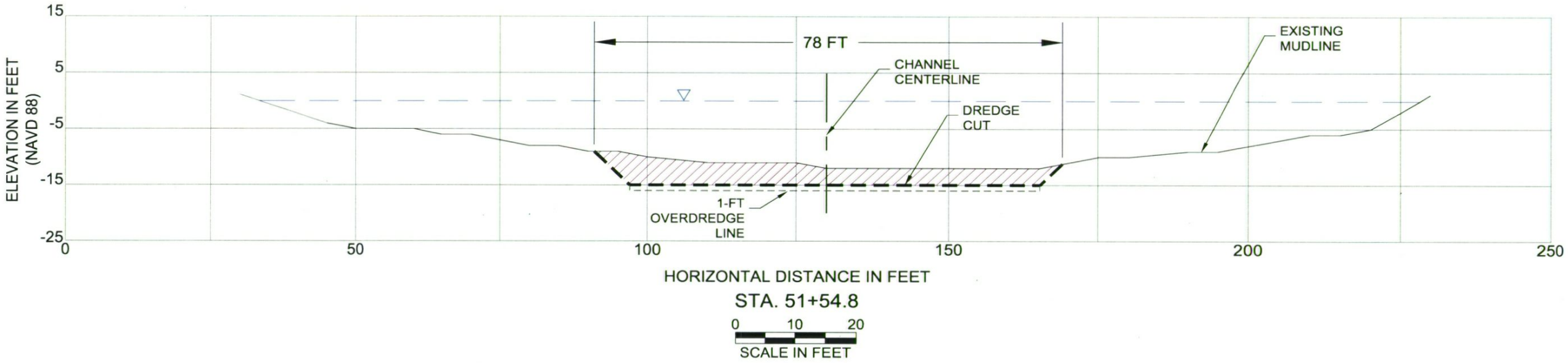
1. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2003.
2. VERTICAL DATUM: NAVD 88
3. LOCATION OF SECTIONS SHOWN ON FIGURE 3-15.

0 10 20
SCALE IN FEET

Jul 14, 2008 1:27pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257010302570 1-044.dwg FIG 3-14

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-14
Sediment Removal in AOI 2 (Option 2), Cross Sections STA 3+10.8 and STA 46+04.3
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



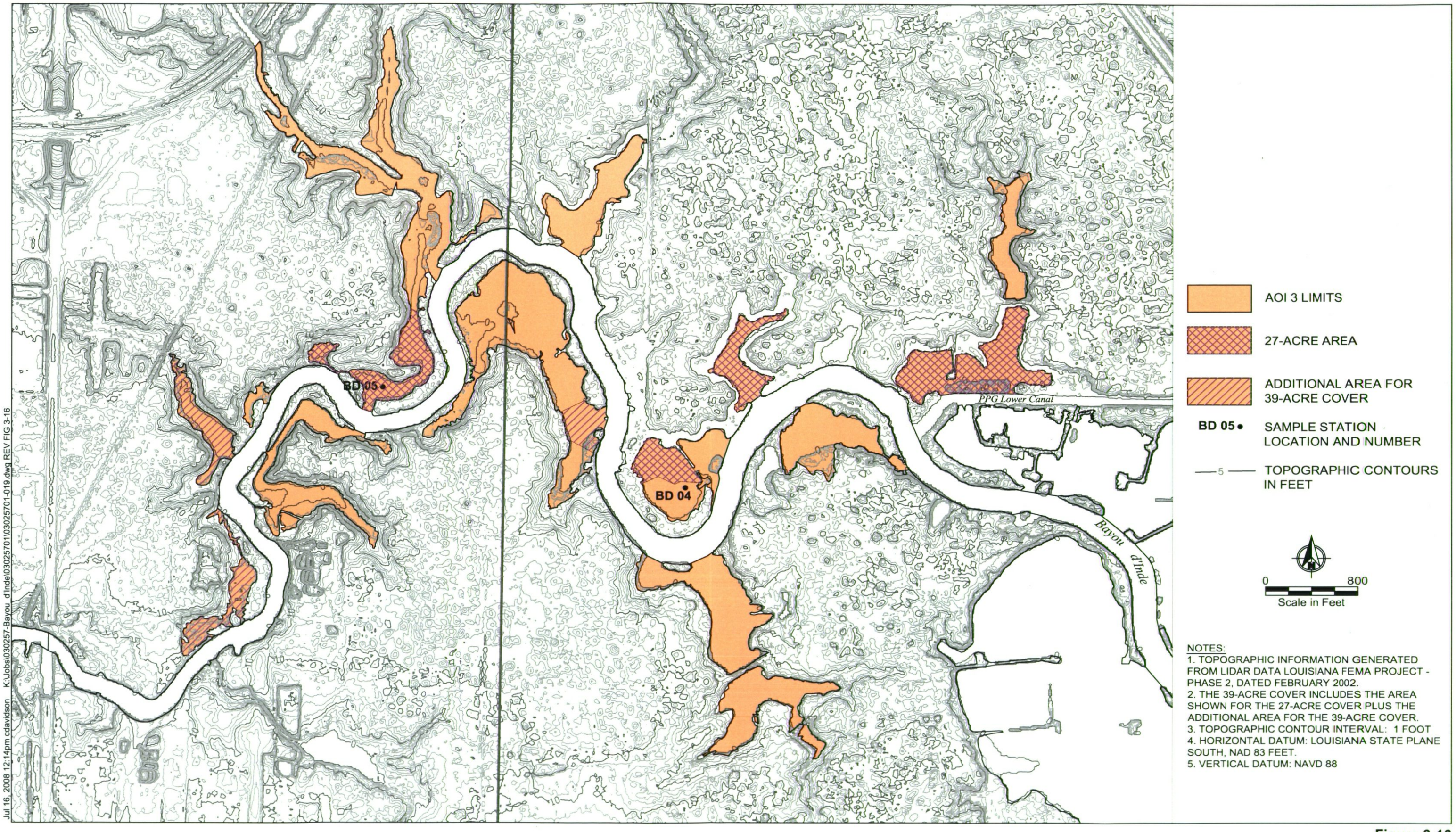
NOTES:

1. BATHYMETRIC INFORMATION GENERATED FROM SURVEY DATA PREPARED BY PPG INDUSTRIES, INC., DATED JANUARY 2003.
2. VERTICAL DATUM: NAVD 88
3. LOCATION OF SECTIONS SHOWN ON FIGURE 3-15.

Jul 14, 2008 1:28pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257010302570 1-044.dwg FIG 3-15

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-15
Sediment Removal in AOI 2 (Option 2), Cross Section STA 51+54.8
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



Jul 16, 2008 12:14pm cdavidson K:\Jobs\030257-Bayou d'Inde\03025701\030257701-019.dwg REV FIG 3-16

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-16
In-Situ Capping in AOI 3
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)

LEGEND

BD 03 • SAMPLE STATION LOCATION AND NUMBER

123-ACRE COVER

—5— TOPOGRAPHIC CONTOURS IN FEET

NOTES:
1. TOPOGRAPHIC INFORMATION GENERATED FROM LIDAR DATA LOUISIANA FEMA PROJECT - PHASE 2, DATED FEBRUARY 2002.
2. TOPOGRAPHIC CONTOUR INTERVAL: 1 FOOT
3. HORIZONTAL DATUM: LOUISIANA STATE PLANE SOUTH, NAD 83 FEET.
4. VERTICAL DATUM: NAVD 88

N

0 400 800
SCALE IN FEET

PPG Lower Canal

11 ACRES

112 ACRES

7-ACRE
I-210 BUFFER

BD-CPT-02

BD-SPT-02

BD-SPT-01

BD-CPT-01

BD 01

BD-CPT-04

BD-CPT-03

BD 03

BD 02

Bayou d'Inde

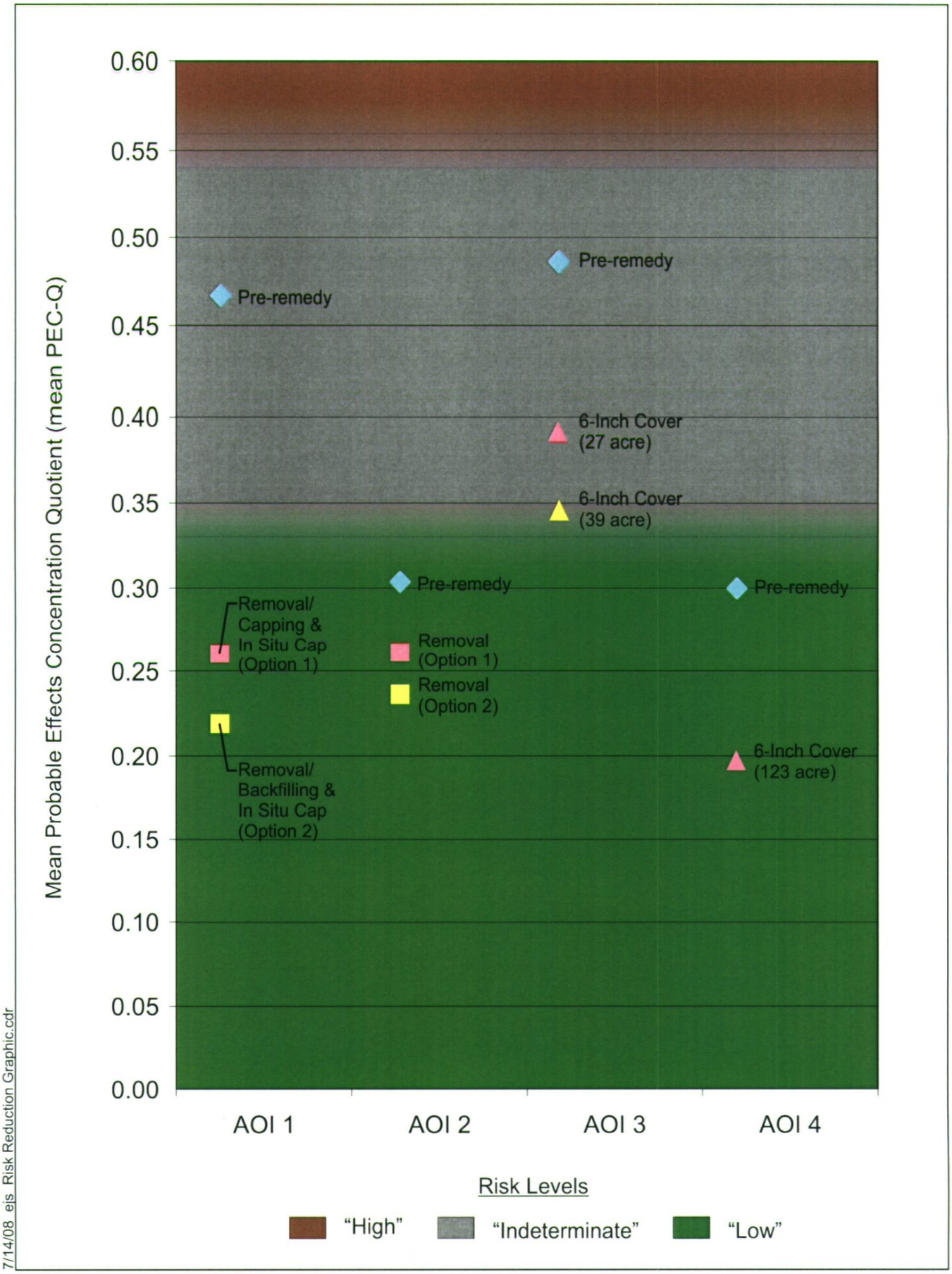
Coon Island Reach of the Calcasieu Ship Channel

Calcasieu River Ship Channel

Jul 14, 2008 1:42pm cdavidson K:\Jobs\030257-Bayou_d'Inde\030257701\030257701-037.dwg FIG 3-17

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3-17
In Situ Capping in AOI 4
Corrective Action Study Report
Bayou d'Inde (Agency Interest 7443)



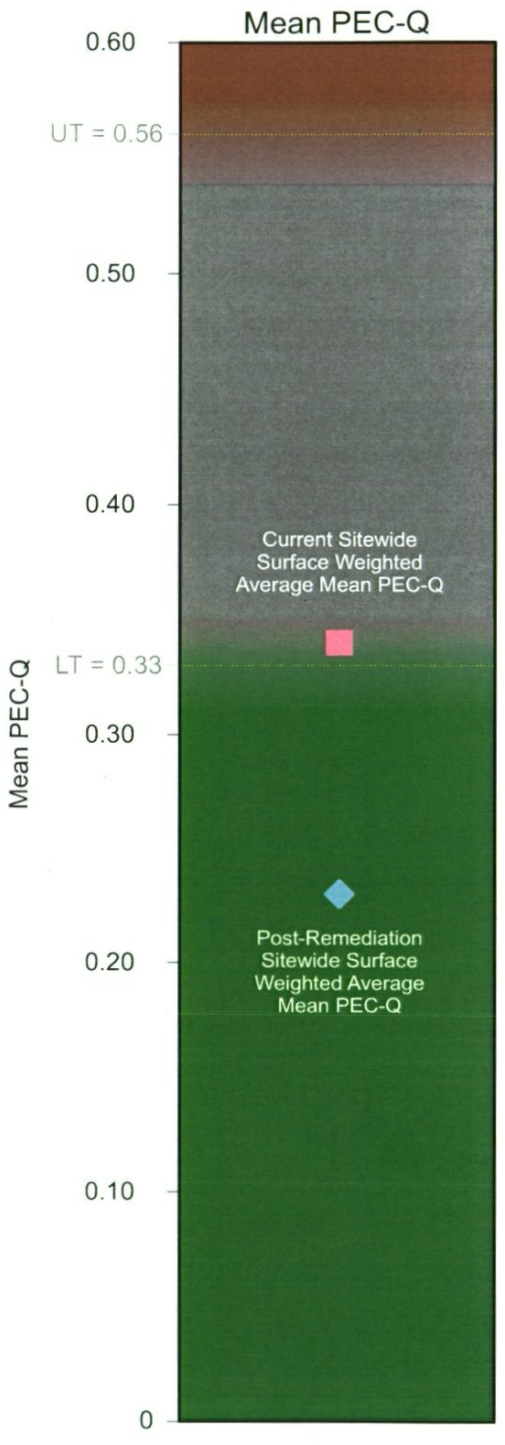
7/14/08 eis Risk Reduction Graphic.cdr

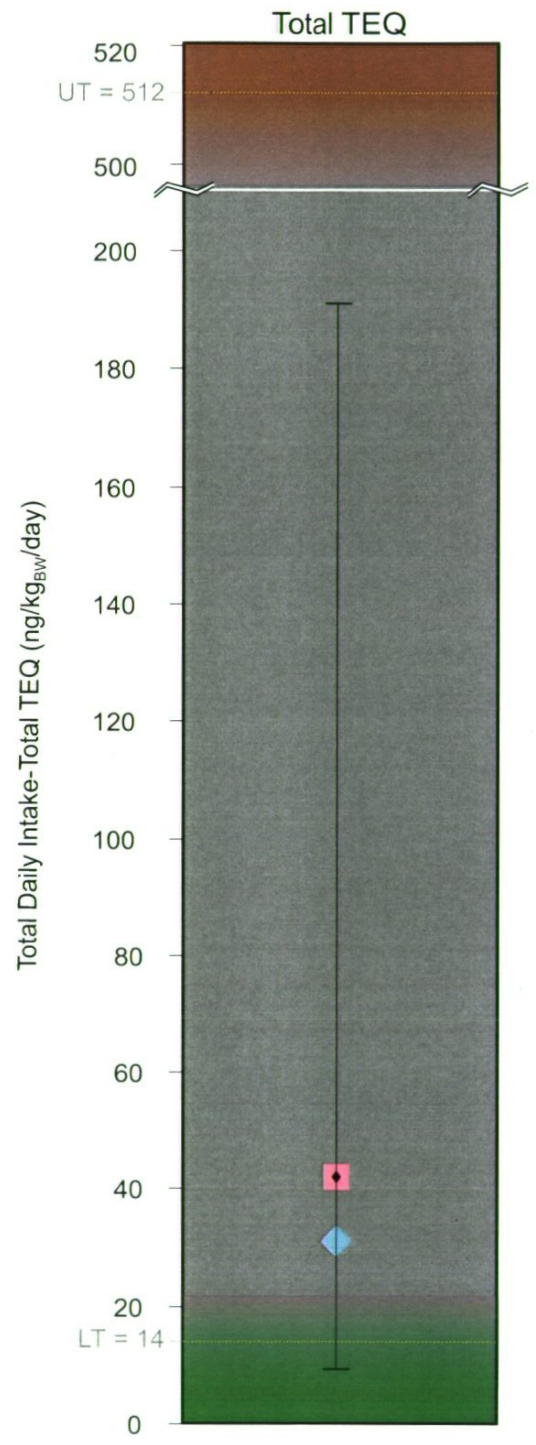
ANCHOR ENVIRONMENTAL, L.L.C.

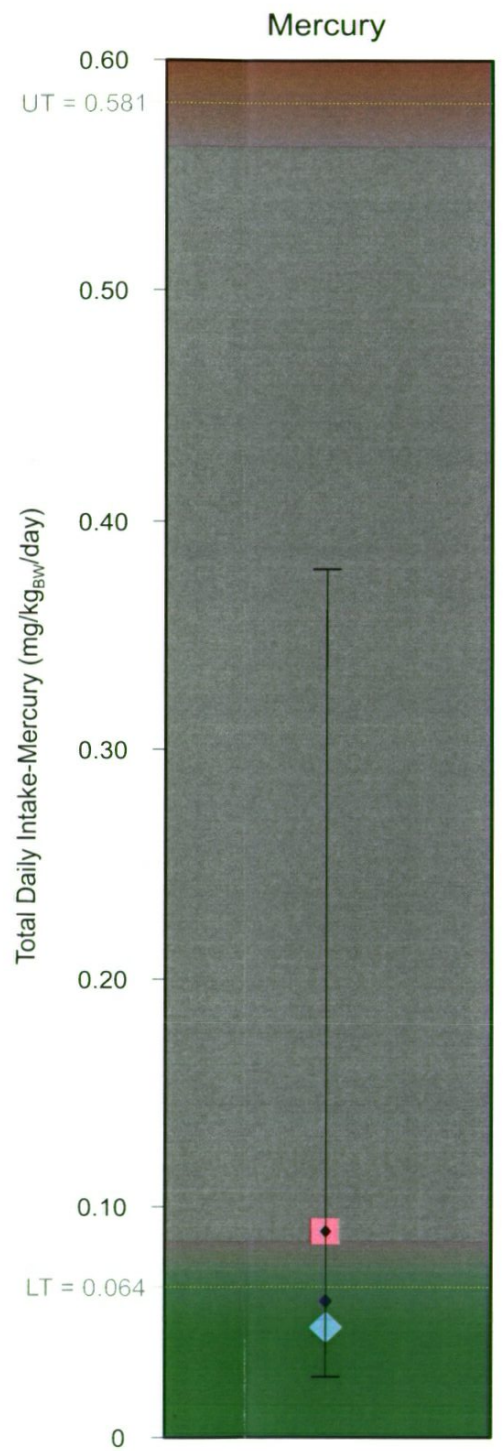
Figure 4-1
Mean PEC-Q Reductions Associated With Remedial Alternatives
Corrective Action Study Report
Bayou d'Inde (AI 7443)

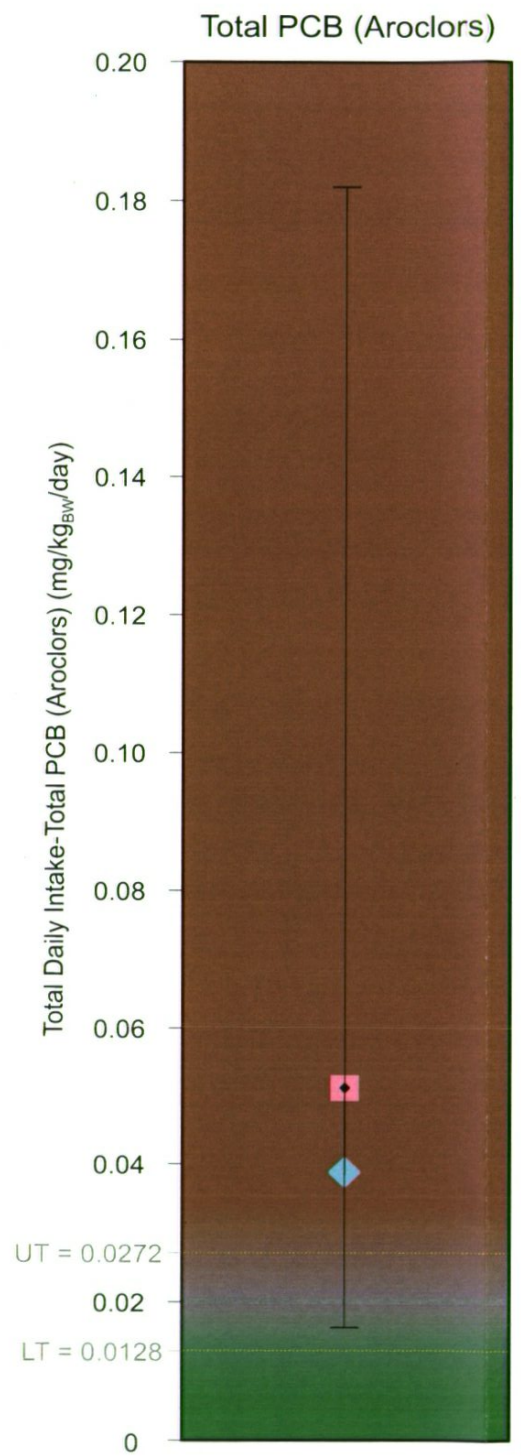
Risk to Piscivorous Birds

Risk to Piscivorous Mammals









LEGEND

- Current Sitewide Mean TDI Value
- Estimated Post-Remediation Sitewide Mean TDI Value
- Range of Modeled Values for Risk-Related Current Sitewide TDI Values

Risk Levels

- "High"
- "Indeterminate"
- "Low"

Note: The Mean PEC-Q and Total Daily Intake (TDI) values shown in gray on the vertical axes on the figures are risk threshold values taken from the BERA (MacDonald Environmental Services Ltd. 2002). The use of these TDI values in the estimation of incremental risks to aquatic-dependent wildlife is discussed at length in the BERA and is summarized in Section 2 of this CAS Report. These TDI threshold values represent the transition from low risk to indeterminate risk (LT) and from indeterminate risk to high risk (UT). The "Current Sitewide Mean TDI Value" is the mean TDI value calculated by EPA in the BERA using tissue data collected during the RI (CDM 2002). This value also includes the range in TDI calculated by EPA. The "Post-remediation Sitewide Mean TDI Value" incorporates the estimated percentage reduction in TDI, or risk, that will result from the implementation of the recommended integrated remedial action, as calculated using the methodology described in Appendix G, and reported in Tables 4-1 through 4-4 and Table 5-1. There is no range associated with this value because it is not known with any certainty how the variance in the distribution of tissue concentrations will change as a result of the implementation of remedial actions in the Site. Note that EPA used the TDI values (and the range, or standard deviation) in a probabilistic risk assessment framework which reported risks as a probability of exceedance of a low or high risk threshold (i.e., TDI). For ease of presentation, this figure does not report risks in a probabilistic manner.

7/14/08 ejs FIGURE 5-1.cdr

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 5-1
Sitewide Risk Reduction
Corrective Action Study Report
Bayou d'Inde (AI 7443)

APPENDICES

Provided on CD

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Description:: 1 CD

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AI# 7443

Calcasieu Estuary
Saltwater Barrier to the Gulf of Mexico
Sulphur, La 71041-0000

Corrective action study report